SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS

-- End of Section Table of Contents --

SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 195	(1995) Mineral Fiber Thermal Insulating Cement
ASTM C 534	(1999) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(1995) Mineral Fiber Pipe Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 647	(1995) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C 795	(1998el) Thermal Insulation for Use in Contact With Austenitic Stainless Steel
ASTM C 916	(1985; R 1996el) Adhesives for Duct Thermal Insulation
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 921	(1989; R 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM E 84	(2000a) Surface Burning Characteristics of Building Materials

ASTM E 96	(1995) Water Vapor Transmission of Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1993) National Commercial & Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 723	(1996; Rev thru Dec 1998) Test for Surface Burning Characteristics of Building Materials

1.2 SYSTEM DESCRIPTION

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

1.3 GENERAL QUALITY CONTROL

1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. The outside surface of insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the

actual construction. Jackets shall comply with the flame spread and smoke developed ratings required by ASTM C 921.

1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Samples

Thermal Insulation Materials

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. Materials furnished under this section of the specification shall be submitted at one time. A schedule indicating the product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA Insulation Stds plates (or detail drawings showing the insulation material and insulating system) for each type of equipment required to be insulated per this specification. The MICA plates shall be marked up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA Plates required to show the entire insulating system, including Plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA Plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and showing provisions for insulating jacketing, and sealing portions of the equipment. For each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., the duct, insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

After approval of materials actual sections of installed systems properly insulated in accordance with the specification requirements shall be displayed. Such actual sections must remain

accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

Pipe Insulation Display Sections: Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric unions and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

Duct Insulation Display Sections: Display sample sections for rigid and flexible duct insulation used on the job. A display section for duct insulation exposed to weather shall be protected by enclosing with a temporary covering.

1.5 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. Insulation material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

PART 2 PRODUCTS

2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

2.1.1 Adhesives

2.1.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I.

2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

2.1.1.3 Contact Adhesive

Adhesive shall be Type II, Class 1.

2.1.1.4 Lagging Adhesive

Lagging adhesives shall be nonflammable, fire-resistant in accordance with NFPA 90A, UL 723, and ASTM E 84. Adhesives shall be either the Class 1 or Class 2 type. Class 1 adhesive shall be pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; or for bonding lagging cloth to thermal insulation. Class 2 adhesive shall be pigmented white and be suitable for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

2.1.2 Contact Adhesive

Adhesive may be dispersed in a nonhalogenated organic solvent with a low flash point (flash point plus or minus 25 degrees F) or, dispersed in a nonflammable organic solvent which shall not have a fire point below 200 degrees F. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable door and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not omit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 2.2 degrees F. The adhesive shall be nonflammable, fire resistant conforming to ASTM E 84.

2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.4 Corner Angles

Nominal 0.016 inch aluminum 1 x 1 inch with factory applied kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.

2.1.5 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449.

2.1.6 Glass Tape

Glass tape shall meet the requirements of UL 723 and ASTM E 84.

2.1.6.1 Plain Weave, Untreated

The ends shall be properly interlocked with the picks to ensure that there shall be no raveling of the tape edges. It shall have an average weight of 5.8 plus or minus 10 percent ounces per square yard, an average thickness of 0.007 plus or minus 0.001 inches, warp ends/wales of 42 plus or minus 2 per inch or filling picks/courses of 32 plus or minus 2 per inch, a minimum breaking strength of 150 pounds per inch of width, and after heating to 900 degrees F for 2 hours a minimum breaking strength of 40 pounds per inch of width.

2.1.6.2 Knitted, Untreated

The wales shall be properly interlocked with the courses to ensure that there shall be no raveling of the tape edges. It shall have an average weight of 4.5 plus or minus 10 percent ounces per square yard, an average thickness of 0.007 plus or minus 0.001 inches,warp end/wales of 16 plus or minus 2 per inch, a minimum breaking strength of 40 pounds per inch of width, and after heating to 900 degrees F for 2 hours a minimum breaking strength of 21 pounds per inch of width.

2.1.6.3 Distortion Requirements

There shall be no distortion of the tape when a sample 24 inches in length is spread across a flat horizontal surface and observed for evidence of distortion (such as tendency to curl rather than lie flat). The width tolerance is plus or minus 1/8 inch.

2.1.7 Staples

Outward clinching type ASTM A 167, Type 304 or 316 stainless steel.

2.1.8 Jackets

ASTM C 921, Type I, moisture vapor transmission maximum 0.02 perms, puncture resistance minimum 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is allowable, tensile strength minimum 35 pound/inch width; Type II, puncture resistance minimum 25 Beach units, tensile strength minimum 20 pound/inch width. Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B 209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105 with factory applied moisture barrier. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inchdiameter and 3/4 inch wide for pipe over 12 inch diameter. Aluminum jacket circumferential seam bands shall be 2 by 0.016 inchaluminum matching jacket material. Bands for insulation below ground shall be 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburg or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place. Polyvinyl chloride (PVC) jacket and fitting covers shall be FS L-P-535, Composition A, Type II, with minimum thickness 0.030 inch. Insulation under PVC jacket shall meet jacket manufacturer's written recommendations.

2.1.9 Vapor Barrier Coating

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall not exceed 0.05 perm and shall be determined according to procedure B of ASTM E 96 utilizing apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type conforming to ASTM E 84, NFPA 90A, and UL 723. The flash point of the compound shall not be less than 80 degrees F and shall be determined in accordance with ASTM D 3278. All other application and service properties shall be in accordance with ASTM C 647.

2.1.10 Wire

Soft annealed ASTM A 580 Type 302, 304 or 316 stainless steel, 16 or 18

gauge.

2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.2.1 Aboveground Cold Pipeline

Insulation for minus 30 degrees to plus 60 degrees F for outdoor, indoor, exposed or concealed applications,, shall be as follows:

a. Cellular Glass: ASTM C 552, Type II, and Type III.

b. Flexible Cellular Insulation:ASTM C 534, Type I.

d. Mineral Fiber: ASTM C 547, Class 1 for use up to 450 degrees F and Class 2 for use up to 650 degrees F.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if aforementionedcleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds standard plates except where modified herein or on the drawings.

3.1.2 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07840 FIRESTOPPING.

3.1.3 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTING, GENERAL.

3.1.4 Installation of Flexible Cellular Insulation

Flexible cellular insulation shall be installed with seams and joints sealed with a contact adhesive. Flexible cellular insulation shall not be used on surfaces greater than 200 degrees F. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV

resistant finish as recommended by the manufacturer after the adhesive is dry.

3.1.5 Welding

No welding shall be done on piping without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.2 PIPE INSULATION INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be continuous and installed on fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

a. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

b. Vertical portions of interior roof drains.

c. Sanitary drain lines.

3.2.1.2 Pipes Passing Through Sleeves

a. Pipe insulation shall be continuous through the sleeve.

f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.

3.2.1.3 Pipes Passing Through Hangers

a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.

b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers with the addition of a Type 39 saddle in accordance with MSS SP-69

d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches

on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible cellular insulation shall conform to ASTM C 921, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Cellular Pipe Insulation

Flexible cellular pipe insulation shall be tubular form for pipe sizes 5 inches and less. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.2 Aboveground Cold Pipelines

The following cold pipelines shall be insulated per Table I minus 30 degrees to plus 60 degrees F:

a. Domestic cold and chilled drinking water.

3.2.2.1 Insulation Thickness

Insulation thickness for cold pipelines shall be determined using Table I.

TABLE I

Pipe Size (Inches)

Service or Range of Temp (degrees F)	Run-outs* 1/4 to 1-1/2	1/4 to 1-1/4	1-1/2 to 3	3-1/2 to 5	6 to 10	11 to 24	25 to 33
60 to 35 (FC)	1/2	1	1				
(CG)		1-1/2	1-1/2	2	2	2	2
(MF)		1	1	1-1/2	1-1/2	1-1/2	1-1/2
34 to 0 (CG)		2-1/2	2-1/2	2-1/2	3	3	3-1/2
(MF)		1-1/2	1-1/2	2	2	2-1/2	2-1/2
-1 to -30 (CG)		3	3	3	3-1/2	3-1/2	4
(MF)		1-1/2	2	2-1/2	2-1/2	3	3
Domestic (FC)		1/2	1/2	1/2			
Cold Water (CG)		1	1	1	1-1/2	1-1/2	1-1/2
and Interior (MF)		1/2	1/2	1/2	1	1	1
Roof Drain Lines (Horizontal portions only)							

*When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like main feed pipe.

LEGEND:

CG - Cellular Glass
MF - Mineral Fiber
FC - Flexible Cellular

3.2.2.2 Jacket for Fibrous and Cellular Glass Insulated Pipe

Insulation shall be covered with a factory applied vapor retarder jacket or field applied seal welded PVC jacket. Insulation inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor barrier jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required.

3.2.2.3 Insulation for Straight Runs (Fibrous and Cellular Glass)

a. Insulation shall be applied to the pipe with joints tightly butted. The ends of fibrous insulation shall be sealed off with vapor barrier coating at intervals not to exceed 15 feet.

b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor barrier coating. All seams, except those on factory self-seal systems shall be coated with vapor barrier coating.

f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor barrier coating. The patch shall extend not less than 1-1/2 inches past the break.

g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor barrier coating.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall have ends thoroughly coated with a vapor barrier coating not more than 6 inches from each flange, union, valve, anchor, or fitting in all directions.

b. Insulation may be premolded or segmented. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation should be overlapped 2 inches or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Insulation for elbows less than 3 inch size shall be premolded. Insulation for elbows 3 inch size and larger shall be either premolded or segmented. Elbows insulated using segments shall not have less than 3 segments per elbow. Insulation may be secured by wire or tape until finish is applied.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor barrier jackets or PVC fitting covers shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

e. Flexible connections at pumps and other equipment shall be insulated with 1/2 inch flexible cellular insulation, unless otherwise indicated.

f. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor barrier and embedded glass tape. Factory premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same thickness as adjoining pipe insulation and the insulation shall be protected with one coat of vapor barrier coating under the PVC cover. The covers shall be secured by PVC vapor barrier tape, adhesive, seal-welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor barrier tape to ensure that the assembly has a continuous vapor seal. Factory or fieldcut blanket insulation shall not be used on pipe below 60 degrees F.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15095

EMERGENCY CLOSURE GATES FOR REGULATING OUTLETS

-- End of Section Table of Contents --

SECTION 15095

EMERGENCY CLOSURE GATES FOR REGULATING OUTLETS

PART 1 GENERAL

1.1 GENERAL INFORMATION

This section covers all work including designing, furnishing, installing and testing two (2) 11-foot by 19.67-foot Emergency Closure Gates with two lifting (pick up) beams, and six (6) sets of gate frames, guides, seal seats, storage facilities and accessories for the Prado Dam Outlet Works.

Each emergency closure gate is intended to be normally stored in a suspended position above any of the six regulating outlet intakes by means of the storage facilities provided above in each intake as shown on the drawings. The closure gate will be picked up with the help of lifting beam from the storage position by means of a mobile crane from the deck at El. 520.0 and lowered under unbalanced water pressure conditions to shut off flow in case of any unforeseen emergency by closing the entrance of any of the intakes as may be needed. The gate will be normally raised under balanced water pressure. However, such raising operation may be needed to jog the gate up and down during emergency closure in case of any problems during such closure and the gates, lifting beams and accessories shall be designed for raising the gates against maximum unbalanced head.

The Contractor shall design all components of the gates, frames and lifting beam and accessories to safely withstand maximum forces during emergency operation and shall determine the crane capacity required. The estimated minimum crane capacity is 50 tons.

1.2 MANUFACTURER PREQUALIFICATION

The emergency closure gates, frames, lifting beams, and all other associated elements shall be the product of a manufacturer regularly engaged in the design and fabrication of water flow shut off gates of similar size and rating. The manufacturer shall submit documentation demonstrating experience in successful design, fabrication, installation and operation of comparably sized gates.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent applicable.

1. AISC Manual for Steel Construction - Allowable Stress Design. (1989)

2. USACOE Manual EM 1110-2-2105, Design of Hydraulic Steel Structures.

3. Design Guidelines for High Head Gates - ASCE Hydro Gates Task Committee (Journal of Hydraulic Division, December 1955).

4. Handbook of Applied Hydraulics, Davis and Sorensen, Third Edition. (1984)

ACI INTERNATIONAL (ACI)

ACI 318	(1995) Building Code Requirements for Reinforced Concrete

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B46.1	(1985) Surface Texture
ANSI Y14.5	(1994) Dimensioning and Tolerancing

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M	(1998a) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 276	(1998) Stainless Steel Bars and Shapes
ASTM A 564	(1995) Hot-Rolled and Cold-Finished Age-Hardening Stainless and Heat-Resisting Steel Bars and Shapes
ASTM B 22	(1995) Specification for Bronze Castings for Bridges and Turntables
ASTM D 395	(1989; R 1994) Rubber Property - Compression Set
ASTM D 412	(1998; Rev. A) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 413	(1982; R 1993) Rubber Property - Adhesion to Flexible Substrate
ASTM D 471	(1996) Rubber Property - Effect of Liquids
ASTM D 572	(1988; R 1994) Rubber - Deterioration by Heat and Oxygen
ASTM D 2240	(1997el) Rubber Property - Durometer Hardness
ASTM D 3951	(1995) Practice for Commercial Packaging
ASTM D 4541	(1995) Pull-Off Strength of Coatings Using Portable Adhesion Testers

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Steel

FEDERAL SPECIFICATIONS (FS)

FS RR-W-410C (1988) Corrosion Resistant Steel For Wire Ropes

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G

Shop drawings and catalog cuts for Contractor-designed details.

All drawings submitted by the Contractor shall have the Contractor's title and drawing number on each drawing. Drawings and data shall show specifications number. All dimensions shall be in feet and inches and all wording, signs,symbols, etc. shall be in English.

Approval Drawings and Data. As soon as practicable after date of award and before proceeding with fabrication or procurement of material, the Contractor shall submit to the Contracting Officer for approval, complete sets of shop drawings, material specifications design conform to the requirements. Any fabrication or procurement per formed, or shipment made, prior to approval of the drawings and data, shall be at the Contractor's risk. The Contracting Officer shall have the right to require the Contractor to make any changes in the equipment design which the USACOE determines necessary to make the equipment conform to the requirements of these specifications without additional cost to the Contracting Officer. Approval by the Contracting Officer of the Contractor's drawings or data shall not be held to relieve the Contractor of responsibility to meet all of the requirements of these specifications or of the responsibility for the correctness of the Contractor's designs and drawings.

Where approval data are required for commercial products or equipment, the Contractor shall submit complete identifying data giving the manufacturer's name, type model, size, and characteristics of the equipment. When a catalog sheet is submitted, the particular item proposed shall be underlined or marked. The data shall be comprehensive and shall fully demonstrate that all equipment provided shall meet the requirements of these specifications. One copy of the approved data will be returned to the Contractor.

SD-05 Design Data

Design Calculations; G

Together with the shop drawings, Contractor shall submit complete set of detailed design calculations for the gates,

frames, lifting beams and storage facilities, including all accessories and appurtenances. The calculations shall be in English and shall use feet, inches and pounds. The calculations should be self-explanatory and shall include copies of all reference materials and data.

SD-06 Test Reports

Test Data; G

During the shop tests, all data needed for proper evaluation of the performance of the equipment shall be recorded. All test data shall be submitted for approval. If the test data do not demonstrate compliance with the specified requirements, all required remedial actions shall be performed and the necessary tests shall be repeated until complete compliance is demonstrated.

SD-08 Manufacturer's Instructions

Installation Instructions; G

The Contractor shall furnish detailed installation instructions, with sequence of installation, drawings, methods of handling and alignment procedures, installation tolerances, special tools and installation equipment needed.

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G

Operating and maintenance manuals shall be submitted for all equipment specified in this Section. The manuals shall include complete parts identification lists and detailed instructions for the operation, lubrication and maintenance of the equipment and for ordering replacements. The manual shall be subject to approval by the Contracting Officer.

1.5 Specification Drawings

The specification drawings indicate the general arrangement, clearances (necessitated by structure and other equipment), maximum overall dimensions and other suggested pertinent features. The Contractor shall be entirely responsible for all design and shall prepare designs and shop drawings in conformity with the specifications and design criteria included in the solicitation. The Contractor shall submit design calculations, shop drawings and catalog data for approval prior to manufacture. The design details, welds and other sizes or dimensions of structural members, shown on Specification drawings as "minimum" are minimums and shall be adopted by Contractor at his discretion.

1.6 DESIGN AND PERFORMANCE REQUIREMENTS

1.6.1 General

The Contractor shall design in conformity with these specifications and references listed in paragraph: REFERENCES as applicable and the following design criteria.

1.6.2 Design Parameters

1. Design Data

Gate Sill Elevation	470.0
Operational Design Head Gate Sill	50 Feet Measured from
Nominal Gate Width	11 Feet 0 Inches
Nominal Gate Height	19 Feet 8 Inches
Type of Gate	Highhead Fixed Wheel Type
Type of Hoist	Mobile Crane
Hydrostatic Design Head	96 Feet from the Gate Sill
Minimum Gate Weight Including Ballast	40,000 Pounds
Number of Wheels	20
Minimum Wheel Diameter	24 Inches
Required Minimum Crane and Lifting Beam Capacity	50 Tons

2. Each gate shall be designed to be suitable for satisfactory and reliable emergency closure under gravity without vibrations, cavitation, oscillations or seizing or galling problems under unbalanced head up to a maximum of 50 feet above the gate sill.

3. Downpull. Downpull on the gate shall be calculated based upon Hydraulic Design Criteria, Sheets 310-2 through 320-2/3 (Revised 10/61) of the U.S. Army Corps of Engineers included in these specifications on the following pages, or other acceptable methods based upon hydraulic model studies on similar installation.

4. Gate Deflection. The maximum allowable deflection of the gate shall be less than 1/1,000 of the span.

5. The gate will be normally raised under balanced pressure condition only unless required to be raised under unbalanced head due to problems during closure operation.

1.6.3 Allowable Stresses

The allowable stresses shall be as specified in EM-1110-2-2105, U.S. Army Corps of Engineers Manual for Design of Hydraulic Steel Structures. Where stress conditions and materials are not covered in EM 1110-2-2105, the following shall govern.

1.6.3.1 Tensile and Compression Stresses

For tensile and compression stresses, the smaller of the values given below will be allowed:

a. For rolled, forged or stainless steel, the tensile and compression stresses shall not exceed 40 percent of yield point or 25 percent of

ultimate strength or 16,200 psi, whichever is lower.

b. For rolled or forged steel bolts, the maximum tensile or compression stresses shall be limited to 25 percent of yield point or 16.5 percent of ultimate strength, whichever is lower.

c. For cast steel, the maximum tensile and compression stresses shall be limited to 33 percent of yield point or 20 percent of ultimate strength, whichever is lower.

d. For cast iron, the maximum tensile strength shall be not greater than 16.5 percent of ultimate strength.

e. For brass or bronze, the maximum tensile and compressive stress shall not exceed 33 percent of yield point or 16.5 percent of ultimate strength, which ever is lower.

1.6.3.2 Maximum Stress for Shear

For shear, the maximum stress shall be less than 0.6 times the allowable tensile stress, except for cast iron, the permissible shear stress shall be equal to the allowable tensile stress.

1.6.3.3 Bearing Stress

Bearing stress between the wheel axle and self-lubricating bronze bushing shall not exceed 6,000 psi or as recommended by the bushing manufacturer.

1.6.3.4 Wheel Friction Formula

The following formula shall be used to estimate the wheel friction:

$$\text{Friction} = P/R(fa \times r + fr)$$

Where:

P = Total Waterload on the Gate

R = Wheel Radius

r = Wheel Axle Radius

fa = Coefficient of Static Friction = 0.2

fr = Coefficient of Rolling Friction = .02

1.6.3.5 Corrosion Allowance

A corrosion allowance of 1/16 inch for structural steel members subject to submergence shall be made.

1.6.3.6 Coefficient of Friction

The coefficient of friction between teflon clad rubber seal and stainless steel shall be assumed as 0.20.

1.6.3.7 Bearings and Bushings.

a. General. Average bearing pressures shall be calculated by dividing

the bearing load by the effective projected area (diameter multiplied by length for round items) of the bearing. Maximum local bearing pressures shall be calculated for unsymmetrically loaded bearings and bushings assuming non-uniform linear pressure distribution along the length of the bearing. When calculating maximum local bearing pressures due to shaft deflection, it shall be assumed that the steel shaft is incompressible and bearing pressures are proportional to the compression of the bearing material.

b. Permanent Self-Lubricating Bushings on Corrosion-Resistant Steel Pins. Average bearing pressure for permanent self-lubricating bearings for normal loading condition shall be two-thirds of the values recommended by the permanent self-lubricating bearing manufacturer, but in no case higher than 4,200 pounds per square inch. The allowable average bearing pressure shall not exceed 5,000 pounds per square inch for overload condition. For maximum allowable local bearing pressures, the values may be increased by 20 percent.

c. Bearing Plates. Loads on bearing plates shall be calculated assuming uniform load distribution and with the normal or overloads loads acting on the gate structure. For rounded plates in contact with rounded or flat plates, the design shall be based on contact (Hertz) stress. Maximum allowable contact (Hertz) stress shall not be more than 135 percent of the minimum ultimate strength of materials for normal loading condition and not more than 150 percent for overload conditions. For hardened steel materials, the allowable contact (Hertz) pressure in pounds per square inch shall be 775 x BHN for normal load condition and 1,065 x BHN for overload condition.

1.6.3.8 Gate Wheels and Track Plates

a. General.

Wheels and track plates shall be checked using maximum wheel load on a single wheel resulting from normal loading conditions on the lower gate section. Wheel treads and track plates shall be hardened as required. Track plates shall have a hardness at least 50 point Brinell hardness number (BHN) higher than the wheel treads. The track plates shall be flat. The wheels shall be cylindrical with provisions to ensure uniform load distribution along the contact line and to avoid stress concentrations due to edge loading. The provisions shall include the use of a self-aligning bearing to permit rotation of the wheel axle due to deflection of the gate under load, adequate clearances to prevent metal-to-metal contact when the axle rotates, and adequate strength of rubber seals in the wheel assembly to withstand the compression caused by the rotation of the wheel axle. Crowned wheels on cylindrical bushings shall not be used without USACOE's approval.

b. Track Plate Mounting.

Track plate shall be mounted to the embedded backing plate by welding. The thickness of the track plate shall be adequate not only for structural strength but also to ensure that the hardness of the track plate surface in contact with the wheels is not affected by welding of the track plate to the embedded backing plate and seal plate, as applicable. The stresses in the track plate to backing plate connection shall not exceed the normal values at load corresponding to a hydrostatic pressure over the entire area of contact between track plate and backing plate equal to a water load of 1.0 times the maximum static head on the track plate, assuming no

compensating forces on external surfaces of track plate or backing plate. It shall be ensured that the concrete beneath the wheel track shall safely withstand the stresses induced by maximum wheel loads. The Contractor shall submit detailed calculations to verify the adequacy of track and track plate mountings.

c. Allowable Wheel Load.

1. Cylindrical Wheels on Flat Tracks. Allowable maximum wheel load shall be:

P = 1/2 (24.5 x BHN - 2,200) x L x D
P = Maximum wheel load, in pounds.
BHN = Minimum Brinell hardness number of wheel tread
L = width of wheel, inches
D = diameter of wheel, inches

2. Crowned Wheels on Flat Tracks. Crowned wheels shall have a diameter ratio (diameter of crown in a section through the axis of the wheel divided by wheel diameter) not exceeding 15. Wheels shall be checked for maximum contact (Hertz) pressures, using maximum wheel load induced by normal loading conditions. Maximum allowable contact (Hertz) pressure in pounds per square inch shall be 775 times the Brinell Hardness Number of the wheel crown.

1.6.3.9 Standard Products

The allowable stresses in all anchor bolts, bearings or other standard manufactured products shall not exceed 90 percent of the values recommended by the manufacturer. Lower allowable stresses shall be utilized wherever necessary or desirable.

1.6.3.10 Concrete

Embedded parts in the concrete structure and parts bearing on the concrete structure shall be designed in accordance with the requirements of ACI 318 and based on a concrete 28-day compressive strength of 4,000 psi. A load factor of 1.7 shall be used for all water loads, and the combined factor dead and live loads shall be multiplied by a "Hydraulic Structural Factor", Hf = 1.3, to compute the required strength, U. When loads from earthquake, overload operating forces, or wind are included, Hf shall be multiplied by 0.75.

1.6.3.11 Operating Forces

a. Force Components

1. General. For calculating the operating loads, either the maximum or minimum value shall be applied to each one of the force components, as shown on Table 1, so that the most conservative results are obtained. It shall normally be assumed that force components act symmetrically except if the design is asymmetrical.

2. Weight. The nominal gate weight component shall include the weight of the ballast (if any), weight of all gate-mounted equipment including the components connecting the gate and crane, and the weight of trapped water, as applicable. Maximum weight shall be calculated by addition of silt load that can accumulate on gate members to the nominal weight.

3. Buoyancy. the nominal buoyancy shall be calculated using the volume of the gate including ballast and any other gate-mounted equipment. Maximum buoyancy shall be calculated by adding the buoyancy due to trapped air to the nominal buoyancy, unless it can be demonstrated that venting of the entrapped air will occur at the same rate as the gate is being closed and assuming specific gravity of water and 1.1 to allow for silt.

4. Hydrostatic Effects. Nominal magnitude of hydrostatic effects shall be calculated using the design geometry of the part or detail under such effect and the applicable hydrostatic pressures. Hydrostatic loads shall be calculated with a specific weight of 62.5 pounds per cubic foot for fresh water.

5. Hydrodynamic Effects. For the wheel gate, the magnitude of hydrodynamic uplift and downpull forces specified in these Specifications shall be considered as the applicable maximum without the need for additional allowances for the gate having characteristic dimensions (gate thickness, location of bottom seal, gate bottom slope, clearance between gate downstream face and concrete wall) within ±5 percent of those shown on the Plans. If the characteristic dimensions are changed during the Contractor's design, new maximum or minimum values, as applicable, shall be established by calculating the theoretical hydrodynamic forces considering the maximum for minimum possible affected areas, maximum or minimum pressure difference, maximum or minimum flow velocities, and other assumptions. Then, at least 15 percent shall be added for the maximum value and 15 percent shall be subtracted for the minimum value.

6. Friction Forces.

(a) General. Maximum friction forces shall be calculated using maximum normal fores and maximum friction coefficients. Minimum friction forces shall be calculated using minimum normal forces and minimum friction coefficients. A differential pressure of 5 psi shall be assumed on the gate during normal raising operation to account for possible leakage through the regulating gate.

(b) Seal Friction Force. The seal friction force shall be calculated by summing the friction caused by the hydrostatic water load acting on the seal and the seal pre-compression force. The pre-compression force shall be used as given by the seal manufacturer or if such data are not available, pre- compression forces shall be determined by tests made by the Contractor. The following seal friction coefficient shall be used in accordance with conservative engineering practice.

Item	Maximum	Minimum
Rubber on steel	1.0	0.3
Rubber on corrosion-resistant steel	0.8	0.2
Fluoro-carbon on corrosion-resistant steel	0.15	0.05
Bronze on corrosion-resistant steel	0.5	0.15

(c) Sliding Friction Forces. Sliding friction forces for gates and guide shoes shall be calculated using the following

minimum and maximum friction coefficients based upon standard engineering practice.

Item	Maximum	Minimum
Corrosion-resistant steel on carbon steel, non-lubricated	0.5	0.1
Corrosion-resistant steel on corrosion-resistant steel	0.18	0.08
Corrosion-resistant steel on corrosion-resistant steel	Not Acceptable	
Bronze on corrosion-resistant steel, non-lubricated	0.4	0.1
Bronze on corrosion-resistant steel, lubricated	0.2	0.07
Self-lubricating bearing on corrosion-resistant steel	0.2	0.06

(d)) Guiding Device Friction. Friction forces shall be calculated using the average operating load on the guiding device and the applicable maximum and minimum friction coefficients.

7. Wheel Gate Bottom Seal Compression Force.

(a) Bottom seal compression force shall be calculated by dividing the sill reaction due to the nominal weight of the gate minus the maximum frictional forces and the buoyancy, when the gate is nearly closed, by the length of the bottom seal.

(b) Bottom seal compression force shall not be less than 250 pounds per foot length of seal.

8. Loading on Wheel Gate Guiding System.

(a) General

(1) The loads specified below shall be used for designing the embedded guiding devices with their anchorage as well as gate-mounted guiding devices with their anchoring and supporting structures including all affected gate parts; they shall also be used for defining force components to be used in operating loading combinations.

(2) Loads that do not cause rotation of the gate shall be considered acting evenly distributed among all participating guiding devices of a rigid gate. Reactions to loads causing rotation in the plane of a rigid gate shall originate only at the upper guiding device on one side and at the lowest guiding device of the opposite side. Reactions causing twisting moment around a horizontal axis in the plane of a rigid gate shall originate only at the upper pair and at the lowest pair of guiding devices.

(3) Forces and reactions on each guiding device shall be considered uniformly distributed over the design contact area. Minimum engagement shall be considered for defining the design contact area.

(4) For guide rail design, the guiding device shall be

considered located both at a guide rail anchorage and also in between a pair of anchorages except for loading conditions corresponding only to a definite position such as for closed or dogged gate section.

(b) Loads of Static Origin.

(1)Loads caused by the geometry, eccentricity of weights and forces, and similar effects related to the arrangement of the equipment shall be determined by customary force calculations. These loads shall correspond to effects such as the following:

direction of pull outside the plan of guides and

seating plane of the closed gate off the plane of center of gravity.

(2) Other loads of static origin such as precompression of seals, reverse water loading, and similar effects shall also be considered.

(c) Guiding Effort and Water Turbulence.

(1) When the gate is not submerged, the guiding effort required to counteract the tendency of gate swinging shall be considered as at least 5 percent of the weight or a surface loading of 4 pounds per square foot, whichever is higher, in either horizontal direction. The gate area to be considered in either direction shall be the projected area of the gate outline.

(2) Effects of water turbulence for all locations where the gate is partially or fully submerged shall be computed on the basis of 20 pounds per square foot differential water load acting on the projected area of the gate outline.

(d) Unsymmetrical Resistance to Operation.

(1) General. Forces parallel to the gate movement and horizontal forces in the plane of the gate due to rotation shall be considered in the manner listed below.

(2) Normal Blocking Load in Lowering. Gate moving downward and stopped by a resistance ("blocking force") at one lower fixed guiding device at one guide. Acting forces shall be the average acting weights of gate and gate-mounted accessories. The acting forces will be partially balanced by the friction forces originated at the two guiding devices receiving horizontal reactions; the remainder of the acting forces shall be balanced by the "blocking force".

(3) Extraordinary Blocking Load in Lowering. This loading condition shall be determined as for the "Normal Blocking Load in Lowering", except that the maximum downward thrust of the hoist shall be used rather than the average acting weight.

(4) Normal Blocking Load in Raising. Gate moving upward and stopped by a resistance ("blocking force") at one upper guiding device at one guide. Acting force shall be the rated pull capacity of the hoist less the weight of the gate. The acting

force shall be partially balanced by the friction forces originated at the two guiding devices receiving horizontal reactions; the remainder of the acting forces shall be balanced by the "blocking force."

(5) Extraordinary Blocking Load in Raising. This loading condition shall be determined as for the "Normal Blocking Load in Raising", except that the maximum pull capacity of the hoist shall be used rather than the rated capacity.

(e) Earthquake Loading. Earthquake forces shall be determined in accordance with Section 13080 of these Specifications.

(f) Normal Loading Combinations. Normal loading on guiding devices shall be obtained by combining the following loads wherever applicable:

Loads of static origin.

Loads due to guiding effort and water turbulence.

Normal blocking loads.

(g) Overload Combinations. Overload combinations on guiding devices shall be obtained by either one of the following summations of applicable loads:

Loads of static origin, loads due to guiding effort and water turbulence, and extraordinary blocking load in raising or lowering

Loads of static origin and loads due to guiding effort and water turbulence.

Loads of static origin combined with earthquake loading.

1.6.3.12 Combination of Force Components

a. Force components shall be combined according to Table 1, "Force Combination Cases", to establish the required operating forces in accordance with standard practice.

b. Where all force components act parallel to each other and the hoist pull, Table 1, "Force Combination Cases", shall be used directly. Where force components are not parallel to each other and to the hoist pull, the moments (around the axis of rotation) caused by the force components shall be used.

TABLE 1
FORCE COMBINATION CASES

Application Force Components	Force Combination Cases I Safety of Closure	II Normal Pull	III Forces on Crane During Lowering Operations
Weight	+ 0.95 Nom.	+ 1.05Max.	+ 1.05 Max.
Buoyancy	-1.05 Max.	- 0.95 Nom.	- 0.95 Nom.
Hydrostatic Uplift	- 1.1 Nom.	- 0.9 Nom.	0
Hydrostatic Downpull	0	+ 1.1 Nom.	+ 1.1 Nom.
Hydrodynamic Uplift	- 1.2 Max.	- 0.8 Nom.	0
Hydrodynamic Downpull	0	+ 1.2 Max.	+ 1.2 Max.
Wheel, Seal and Guide Friction	- 1.3 Max.	+ 1.3 Max.	- 0.8 Min.

1.6.4 Materials

The following materials and material specifications shall be used. If the bidder intends to substitute any of the materials, he should clearly state so in this bid and the reasons for substitution. He shall submit the specifications for such alternative materials.

1. Gate leaf, frames, guides and lifting beam shall be of structural steel conforming to ASTM A 36/A 36M.

2. Gate seal seats shall be of stainless steel conforming to ASTM A 276, Type 316.

3. Wheel track shall be of stainless steel conforming to ASTM A 564, Type 630.

4. Gate wheels shall be of stainless steel conforming to ASTM A 564 Type 630.

5. Wheel pins shall be of stainless steel conforming to ASTM A 276, Type 316.

6. Seal fasteners shall be of stainless steel conforming to ASTM A 276, Type 316.

7. Permanent self-lubricating bronze bearings shall be of cast bronze alloy conforming to ASTM B 22, Alloy 863 with self-lubricating inserts, Lubrite or equal.

8. Wire ropes shall be of corrosion resistant steel conforming to FS RR-W-410C 1 WRC.

9. Wire rope fittings shall be of corrosion resistant steel conforming to Manufacturer's Standards.

10. Lubricating fittings shall be Alemite, Type A-1188 or A-1184, as manufactured by Alemite division of Stewart Warner Corp., 1826 West Diversey Parkway, Chicago, IL 60614, or equal.

11. Grout for machinery shall be non-shrink epoxy grout.

12. Fluoro-carbon (PTFE) bushings and washers shall be "Rulon A" as manufactured by the Dixon Industries Corporation, Bristol, RI 02809, or equal.

13. High strength fiber-reinforced phenolic bearing material shall be "ORKOT TLM" as manufactured by ORKOT Engineering Plastics, 2535 Prairie Road, Unit D, Eugene, Oregon 97402, or equal.

14. Neoprene seals shall be molded of neoprene compound or copolymer of butadiene and styrene or a blend of both. The compound shall contain not less than 70 percent by volume of the basic polymer, and the remainder shall consist of reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers conforming with Tensile Strength 3,000 psi - ASTM D 412, Elongation at Break 450 percent, Water Absorption by Weight 5 percent - ASTM D 471, Compression Set 30 percent of Original - ASTM D 395.

15. Fluoro-carbon clad rubber seals shall be Rubber seals shall be as specified above. A fluoro-carbon sheath shall be bonded to the rubber on the sealing surface. The sheath shall be abrasion resistant Fluoro-Carbon Film No. 4508 as manufactured by Buckhorn, Inc., 55 West Technecenter Drive, Milford, OH 45150, or equal. The outside surface of the fluoro-carbon sheath shall be free of adhering or bonded rubber conforming with ASTM D 412, ASTM D 2240, ASTM D 471, ASTM D 395, ASTM D 572, and ASTM D 413 (Friction Test).

16. Elastometric sealing rings (O-rings) shall be Vulcanized compound of Nitrile Butadiene Rubber. Durometer A hardness 55±5. Tensile Strength 2,500 psi minimum.

17. Lubricating oil shall be ISO VG 46, Mobil D.T.E. Oil Medium or Shell Turbo Oil T46, or equal.

1.6.5 Anchors and Alignment Provisions

The Contractor shall be responsible to design and provide adequate number of anchors welded to the gate frames. These frames, together with anchors, should be designed for external water load equal to the maximum pool pressure. External tension anchors shall transfer the water load to the concrete by compression and/or bearing and shall prevent the gate frames from collapsing inward if leakage occurs around them. The allowable tensile and bending stresses in the structural steel members and anchors shall not exceed 16,200 pounds per square inch.

The Contractor shall also provide adequate alignment anchors with turnbuckles to permit precise alignment of the gate frames. Provisions such as seats welded to frames for hydraulic jacks and other erection tackle shall be made.

1.6.6 Surface Roughness and Finish

The Contractor shall indicate on his submittal drawings the surface roughness specified by numbers in check-type marks on the surfaces, which shall be machine finished and shall conform to the surface quality specified in ANSI B46.1, entitled, "Surface Texture", published by ANSI.

1.6.7 Tests of Materials

1.6.7.1 General

All materials or parts used in the equipment shall be tested, unless otherwise directed, in conformity with applicable methods prescribed by the ASTM, or such other organizations as may be specifically required, and in general accordance with the best commercial methods. When requested, tests shall be made in the presence of the Government representative. Stocked material may be used provided evidence is furnished showing that such material meets the specified requirement, in which case tests on stocked material may be waived.

1.6.7.2 Test Reports

Certified material test reports shall be furnished. The test reports shall identify the component for which the material is to be used and shall contain all information necessary to verify compliance with the Specifications.

1.6.8 Workmanship

1.6.8.1 General

a. All work shall be performed and completed in a thorough workmanlike manner and shall follow the best modern practices in the design and manufacture of gates and hoists. All work shall be done by personnel skilled in the related professions and trades. All parts shall be made accurately to standard so as to facilitate replacement and repairs. All bolts, nuts, screws, rivets, threads, pipe, gages, gears and measurements or dimensions shown on the Plans shall conform to U.S. standards. Dial special gages and templates necessary for field erection of the wheel gate shall become the property of the Government.

b. Like parts and spare parts shall be interchangeable wherever possible. Machining of fits on renewable parts shall be accurate and to specified dimensions so that replacements made to the size shown on the shop drawings may be readily installed.

c. The design and fabrication of the wheel gate equipment shall provide for adequate adjustment (by the use of shim plates or oversized holes) so that there are minimal interfacing difficulties during erection.

1.6.8.2 Welding

a. General. All welds shall be continuous and watertight. All welding shall be performed by the electric-arc method, by a process that excludes the atmosphere from the molten metal, and where practicable, by automatic machines. Machined surfaces of parts affected by welding shall be machined to final dimensions after welding. Machined surfaces of parts requiring stress relief shall be machined to final dimensions after the parts have been stress relieved. Localized stress relieving will not be permitted for shop welded parts.

b. Minimum Weld Requirements. All welds shall be made continuous and watertight. The minimum size of fillet welds shall be 1/4 inch measured on the leg except if otherwise specified. Welds larger than 5/16 inch shall be made in not less than 2 passes. All groove welds including butt welds shall be full penetration, welded from both sides.

c. Preparation of Base Material. Members to be joined by welding shall be cut to shape and size by mechanical means such as shearing, machining,

grinding, or by gas or arc cutting, to suit the conduits. The design of welded joints and the selection of weld filler metal shall allow thorough penetration and good fusion of the weld with the base metal. The edges of surfaces (up to the thickness of the metal) to be welded shall be sound metal free of visible defects, such as laminations or defects caused by cutting operations, and free from rust, oil, grease, and other foreign matters.

d. Technique of Welding. The technique of welding, the appearance and quality of the welds, and the methods used in correcting defective work shall conform to the AWS D1.1. Special care shall be taken to avoid undercuts along the seams or warping of the structure. If undercuts appear along the welds, they shall be filled using a small diameter electrode of the same composition as the original electrode after slag, if any, is removed. Continuous and uniform maintenance of preheat and interpass temperatures will be required for all welds. Local preheating shall be used only for repairs on welds. Preheat and interpass temperature shall also be as outlined in the welding procedure according to the applicable sections of AWS D1.1 or ASME Code, Division 1.

e. Welding Qualifications. The qualification of welding procedures, welders, welding operators, and tackers shall conform to standards at least equal to Section 5, "Qualification" of AWS D1.1. The Contractor shall furnish all facilities and all equipment, materials, and other articles required to conduct qualification tests of his welders and welding operators. Certificates of welders' qualifications shall be submitted when requested.

f. Weld Finish. Welds shall, in general, be treated so that they will display good appearance and a surface suitable for painting. Structural welds shall be ground and blended to avoid stress raisers. All welds which require nondestructive examinations shall be dressed by chipping and grinding as required for good interpretation by the selected weld examination methods.

g. Environmental Requirements. Recommendations of the ASME Code, Section VIII, Division 1, Paragraph UW-30, shall be observed for temperature and weather conditions for welding.

1.6.8.3 Castings

a. General. Castings shall be free from injurious defects and shall be satisfactorily cleaned for their intended use. All bronze castings for bushings and bearings shall be centrifugally cast unless approved otherwise. Surfaces of castings which are not machined shall be dressed for good appearance and for painting. The location of existing defects shall be determined, and all defects which impair the strength or utility of the casting shall be removed to sound metal before repair. The structure of the castings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in the casting will be cause for its rejection.

b. Repair Welding. Minor defects that will not impair the strength or serviceability of the castings may be repaired by welding in accordance with accepted foundry practice without review by the Contracting Officer. Defects shall be considered minor when the depth of cavity properly prepared for welding is not greater than 25 percent of the actual wall thickness but in no case greater than 3/4 inch and when the area to be

welded is smaller than 8 square inches. However, an accumulation of minor defects which, in the opinion of the Engineer, casts doubt as to the general quality of the casting shall be considered as a major defect. A complete descriptive report of major defects, supplemented with sketches, photographs, and metallurgical test reports, as the case may warrant, and the proposed reaper procedure shall be submitted for review prior to any repair of major defects. If removal of defects reduces the stress-resisting cross-section of the casting by more than 30 percent, the casting may be rejected. All castings repaired by welding of major defects after heat treatment shall be heat treated again.

1.6.8.4 Nondestructive Testing

a. General. Unless otherwise indicated, all nondestructive tests shall be in accordance with the applicable sections of ASTM Volume 03.03. The shop drawings shall define the areas, extent and type of nondestructive examinations to be employed. Personnel who perform or interpret nondestructive tests shall be qualified in accordance with ASNT Recommended Practices No. SNT-TC-1A 1988 Edition # 2045, Level II or III.

b. Examination of Welds. All critical welds, including all welds on primary structural components, shall be given complete nondestructive examination by radiographic, ultrasonic, magnetic particle, or dye-penetrant methods, as applicable or specified, throughout the entire length. Full penetration welds shall be given nondestructive examination throughout their entire length by radiographic examination. Where radiographic examination is not feasible or results are likely to be doubtful, ultrasonic supplemented by magnetic particle or liquid penetrant methods shall be used. All welds (100 percent) shall be inspected visually throughout their entire length. The Contracting Officer shall have the right to request random spot-check examination of welds, including radiographic examination, as part of the equipment inspection. Examination of welds shall be in accordance with the technique and acceptance standards of Section VIII, Division 1, of the ASME Code. Ultrasonic examination shall meet the technique and acceptance standards as defined by ASME Code, Section VIII, Appendix 12. Radiographic examination shall meet the technique and acceptance standards of Paragraph UW51, Section VIII, Division 1, of the ASME Code. Magnetic particle and liquid penetrant examination shall meet the technique and acceptance standards as defined by ASME Code, Section VIII, Division 1, Appendices 6 and 8, respectively. Where stress relieving is required, nondestructive examination shall be performed after stress relieving.

c. Examination of Castings

1. Castings for major components shall be given a complete ultrasonic examination and a radiographic examination insofar as practicable. No casting will be accepted having defects larger than those indicated under (14.13), C.2. Repair Welding, above. Where radiographic examination is not practicable due to configuration or accessibility, other nondestructive examination, subject to the Contracting Officer's review, may be substituted.

2. Inspection. Castings shall be inspected visually at the foundry after they are cleaned and while defects are being removed. Castings shall also be inspected after repairs and after heat treatment. Radiographic or other nondestructive tests will be required as specified and as directed when permission is granted to repair major defects. The Contracting Officer shall have the right to require

nondestructive tests at the Contractor's expense to determine:

(a) The full extent of defects.

(b) That the area is properly prepared for welding.

(c) That the repairs are satisfactory.

d. Examination of Forgings. Major forgings shall be given ultrasonic examination with liberal overlap and other applicable nondestructive tests, to determine that they are sound. Nondestructive examination of minor forgings shall be in accordance with accepted good practice to assure their soundness. The structure of forgings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a forging will be cause for its rejection.

1.6.8.5 Machine Work

a. General. Sufficient machining stock shall be allowed on all parts to be machined to ensure true finished surfaces of solid material.

b. Finished Surfaces. In addition to the machined surfaces indicated on the specification drawings, all surfaces that require machining for their intended function and those surfaces that are normally machined in good shop practice shall be machined. Finished contact or bearing surfaces shall be true and exact to secure full contact. Journal and sliding surfaces shall be polished and all surfaces shall be finished with sufficient smoothness and accuracy to insure proper operation when assembled. No machining shall be done on working surfaces of self-lubricating bushings or washers. Corrosion-resistant-steel, seal plate surfaces in contact with seals shall be thoroughly cleaned and machined to have a smooth and even surface.

c. Pins and Pin Holes. Pin holes shall be drilled smooth and straight and at right angles to the axis of the member. The drilling shall be done after the member is securely fastened in position and shall be line bored in one set-up where practicable.

d. Unfinished Surfaces. All work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the specification drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in an approved manner.

e. Assembly. Before assembly, all bearing surfaces, journals and grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. After assembly, each lubricating system shall be filled with an approved lubricant. Self-lubricating bearings shall be treated according to the manufacturer's instructions.

1.6.8.6 Tolerances

a. General. All tolerances shall be selected to correspond to the accuracy required for the proper operation of the equipment considering the nature and function of the part. Plate thicknesses shall be governed by

ASTM A 6/A 6M.

b. Designations. Tolerances shown on the Plans and specified elsewhere in these Specifications have been designated as follows: dimensional tolerances for cylindrical parts in the ISO system, position and form tolerances in accordance with ANSI Y14.5, and surface finish designations in accordance with ANSI B46.1. Surface finish designations are in micro inches as determined by the root-mean-square (RMS) method. The Contractor shall use these same standards for symbols and designations, or shall submit with the first review shop drawings alternative designation codes and their correspondence with the specified standards.

c. Selection

1. General. The tolerances specified in these Specifications and on the Plans are maximum tolerances applicable to the equipment when it is installed. Finer shop tolerances shall be established, if necessary, to meet the specified design or operational requirements or for interchangeability of spare parts. All tolerances shall be selected with due consideration to the nature and function of the parts, to the effects of cumulative tolerances and to the corresponding accuracy required to secure proper operation, but they shall not exceed the tolerances specified below.

2. Wheel Gates

(a) Skinplate. Bottom and top edge of the skinplate of each gate section shall be parallel within ± 0.010 inch per 5 feet of height. Length of diagonals connecting skinplate corners shall be within ± 0.003 inch for any 5 feet of skinplate perimeter but in no event shall exceed ± 1/4 inch of nominal dimensions. Bottom of the skinplate and the top of the skinplate on each gate section shall be straight within ± 0.050 inch over any 10 feet of length and ± 0.010 inch over any 5 feet of length.

(b) Wheels. The rolling surfaces of all wheels on each gate section or the assembled gate shall be in the same plane within ± 0.010 inch. The rolling surfaces of the wheels on each side of a gate section or the assembled gate shall be in line within ± 0.005 inch. The distance between wheels on opposite sides of a gate shall be within 0.100 inch. The rolling surface of each wheel shall be round within ± 0.005 inch and shall have no sudden steps greater than 0.001 inch.

(c) Seal Seat Bars. Seal seat bars for side seals shall be within 1/16 inch of a plane parallel to the rolling surface of the wheels. Seal seatbars for top seals shall not have more than 0.050 inch of camber over any ten feet of length, or 0.010 inch of camber over any five feet of length. The maximum total camber over the entire span shall not exceed 0.060 inch.

(d) Plumbness. The assembled wheel gate when hung vertically from its lifting lugs shall be plumb within ± 1/4 inch to a horizontal axis and within ± 1/16 inch to a vertical axis.

3. Embedded Parts for Wheel Gate

(a) Sealing Surfaces. Each embedded sealing surface shall be within ± 0.050 inch of the design plane along its length and ±

0.010 inch across its width.

(b) Tracks for Wheel Gate. Upstream as well as downstream tracks for wheel gates shall be within ± 0.050 inch of the design plane along their length and ± 0.005 inch across their width. Tracks shall be checked for straightness by means of a ten foot (minimum length) straight edge and feeler gages and shall be straight within ± 0.01 inch over any 10-foot length or ± 0.002 inch over any 5-foot length. Sudden steps on track surfaces shall be not more than 0.001 inch high. Track plates shall be parallel across the opening within ± 0.0050 inch. The distance in the flow direction between the upstream and downstream track plates shall be within ± 0.050 inch.

(c) Sealing Frame

(1) Side and top seal places shall be in the same plane within ± 0.050 inch.

(2) Sill beam shall be in the design plane and within ± 0.050 inch. Centerline of the sill beam shall be perpendicular to the side and top seal plates plane within ± 0.050 inch.

(3) Length of diagonals connecting interior corners of the assembled sealing frame shall be within ± 0.003 inch for any 5 feet of seal perimeter but in no event shall exceed ± 1/4 inch of design dimensions.

(4) Guides. All guiding surfaces of each guide shall be straight within ± 0.050 inch over any 10-foot length. All guides shall be parallel with their opposite guide across the opening within ± 0.125 inch.

1.7 DESIGN CRITERIA

1.7.1 Function

All equipment and components shall be suitable for performing safely its intended functions as described in these Specifications and Contract Documents.

1.7.2 Features Shown on the Specification Drawings

1.7.2.1 General Arrangement

The general arrangement of the equipment shall conform to the specification drawings.

1.7.2.2 Mandatory Features

Mandatory features shown on the specification drawings shall be adopted without substantial change or substitution. Alternative arrangements and alternatives for mandatory features will be accepted only if in the judgement of the Contracting Officer the result is not inferior to that of the arrangement and details shown on the specification drawings. Mandatory features shall be the following dimensions, elevations, tolerances, other data or aspects:

a. All features referring to related work, such as civil work outline and

dimensions of equipment.

b. All elevations, except if designated as "approximate" or "subject to variations".

c. The general layout and arrangement of the equipment and its major parts, including the dimensions defining location of the equipment relative to the civil work.

d. Dimensions, clearances, etc. designated by "maximum", "minimum" to be applied as upper or lower limit for the design.

e. All reference to the use of a specific material or a specific group of materials.

1.8 QUALITY ASSURANCE

The Contractor shall ensure that required tests, workmanship, and other performance aspects of the work comply with the applicable quality assurance requirements specified herein. In accordance with FAR 52.246-2, INSPECTION AND ACCEPTANCE, the Contractor shall provide continuous inspection of all operations for quality control and record the results for submitting to the Contracting Officer to show compliance with the Contract requirements.

1.9 DELIVERY, STORAGE AND HANDLING

1.9.1 Packaging

The equipment shall not be prepared for shipment until they have been inspected and accepted for shipment at origin by the Contracting Officer or his authorized representative, unless inspection has been waived in writing. Each component of equipment or subassembly shall be shipped completely assembled. The subassemblies shall be defined as the following:

1. Gate leafs.
2. Gate frames.
3. Sill beams.
4. Storage facilities.
5. Lifting of beams.

The subassemblies shall be provided with adequate protective pads, supports and blocking and shall be securely restrained to prevent distortion or damage to the painted surfaces in transit. Any loss or damage during shipment, including damage to the painted surfaces, will be considered the responsibility of the Contractor, and shall be replaced or repaired without cost to the Government. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY", or "SPARE PARTS ONLY". A packing list, listing the contents of each container, shall be placed in a moisture-proof envelope and securely fastened to the outside of the container. Standard commercial packaging in accordance with ASTM D 3951 will be acceptable except where a different method or standard of packaging is specifically called for herein.

1.9.2 Shipping, Preservation and Storage

1.9.2.1 General

Packing, crating, cradles, etc., necessary to ensure safe shipment are the responsibility of the Contractor and shall become the property of the Government upon delivery of the equipment.

Machined surfaces shall be adequately protected from corrosion and physical damage. Equipment delivered and placed in storage shall be stored with protection from the weather, humidity, temperature variation, dirt and dust, or other contaminants.

Small parts, such as bolts, anchor bolts, and other interchangeable parts which are packaged together for shipment, shall have the package labeled with the solicitation number, the part number, and the complete assembly identification.

Shipping shall be in accordance with applicable regulations and the following provisions.

1.9.2.2 Preparation for Shipment

a. General. The manufacturer shall prepare, pack and load all materials and equipment for shipment in such a manner that they are protected from damage during shipment and shall be responsible for and make good any and all damage resulting from improper packing. Items subject to open storage for several months at the site shall be suitably protected from weather damage. Where necessary, heavy parts shall be mounted on skids or shall be crated and any articles or materials that might be otherwise lost shall be boxed or steel banded in bundles and plainly marked for identification. All parts exceeding 200 pounds gross weight shall be prepared for shipment so that slings for handling by crane may be readily made. All parts subject to damage from moisture shall be packed in hermetically sealed metal containers or plastic envelopes with sufficient quantities of a hygroscopic material inside or in other approved containers, within their respective packing cases, with all machined surfaces heavily coated with a rust preventing compound. Each case, crate, bundle and single items shall be marked clearly with the name of the installation for which it is intended. Each container shall be clearly marked and the contents identified for proper warehousing. All fasteners and miscellaneous plates, templates, and fixtures required for field connections, splices, alignment, etc. shall be shipped in marked boxes keyed to the erection drawings. A complete packing list shall accompany each shipment.

b. Spare Parts. All spare parts shall be packed separately in containers plainly marked "Spare Parts Only" and indicating the items of equipment to which they belong. A packing list, indicating the contents of the container, shall be securely fastened in a moistureproof envelope to the outside of each container. The packing list shall also provide the following information:

1. manufacturer,

2. contract number, and

3. identification, including manufacturer's drawing number, of each spare part in the container.

1.9.2.3 Release for Shipment

No equipment shall be shipped to the site until a written release for shipment is received by the Contracting Officer.

1.9.2.4 Statement of Conformance

The manufacturer shall prepare a Statement of Conformance to accompany each equipment or material shipment sent to the Site, in order to provide certification by the manufacturer that the equipment and required documentation meet all requirements of these Contract Documents. The manufacturer's representative officially responsible for assuring that all requirements of these Contract Documents are met shall sign the Statement of Conformance.

1.9.2.5 Shipment

The manufacturer shall be responsible for obtaining shipping space, for insurance for the full value of the equipment until delivery at the delivery point, for freight, for securing and forwarding the shipping documents, and for the payment for all duties and shipping charges. It shall be the manufacturer's responsibility to establish the maximum shipping limitations for delivery to the delivery port.

1.10 PROJECT/SITE CONDITIONS

The Contractor shall visit the site to thoroughly familiarize himself with all details of the work, access, working conditions and constraints to verify dimensions in the field and he shall then advise the Contracting Officer of any discrepancies prior to performing any work. The Contractor shall be specifically responsible for the coordination and proper relation of his work to the structure and work of all trades.

1.11 WARRANTY

The Contractor shall guarantee all equipment for a period of 5 years from the date of acceptance. Replacement parts shall be guaranteed for 5 years from date of replacement. Warranty shall be against defective materials, design, and workmanship. In cases where the equipment manufacturer's advertised minimum guarantee is in excess of 5 years, it shall remain in force for its full period. Upon receipt of notice from the Contracting Officer of failure of any of the parts during the warranty period, new replacement parts shall be furnished and installed promptly at no additional cost to the Contracting Officer. Any operational problems shall be rectified to the satisfaction of the Contracting Officer at Contractor's expense.

PART 2 PRODUCTS

2.1 EMERGENCY CLOSURE GATES

2.1.1 General

Materials and mechanical equipment shall conform to the requirements indicated on the specification drawings or referred to herein, and when not covered thereby, materials and mechanical equipment of the best commercial grade quality suited to the intended use and as approved by the Contracting Officer shall be furnished. The manufacturer's name, address, and catalog number shall be permanently displayed on a nameplate securely attached to each major item of equipment.

Where items are referred to hereinafter as "similar and equal to" a particular manufacturer's product, such references have been made merely as a convenient method of indicating the type of material or equipment required, with no intention of asserting superiority thereof. The standard product of any reputable manufacturer regularly engaged in the commercial production of the type and quality of material or equipment referred to will not be excluded on the basis of minor differences, provided essential requirements of the specifications relative to materials, capacity, and performance are met. The Contractor shall, in accordance with Paragraph: SUBMITTALS, furnish for approval, performance capacities and other pertinent information concerning the manufacturer's "equal to" standard products which he intends to incorporate in the work. "Equal to" standard products installed or used without such approval shall be at the risk of subsequent rejection.

2.1.2 Fixed-Wheel Emergency Closure Gates

Each gate shall be rectangular in shape. The nominal height of 19.67 feet and the nominal width of 11.0 feet represent the dimensions of the waterway immediately downstream of the gate. The gate shall be fabricated of structural steel in separable units of approximately equal height if so needed for transport. The units will be of welded construction and shall be accurately aligned with dowels and bolted together for field assembly. The mating faces of the units shall be machined so that the assembled units will not be distorted when the bolts are drawn tight. The skinplates or load-bearing plates, and the gate seals shall be on the downstream and bottom sides of the gate. The bottom of the gate must be shaped so as to avoid vibrations and minimize hydrodynamic downpull or uplift forces, in order to ensure smooth closure operation under maximum operational head. The bottom seating surface of the gate shall be normal to the longitudinal gate axis, shall be parallel to the gate sill as installed, and finished for uniform bearing on the sill.

Gate wheels shall be of stainless steel; unflanged, and rims shall be cylindrical and suitably hardened. Each wheel shall be bored for and provided with a pressed-in self-lubricating bronze bushing which will turn on an 18-8 chrome- nickel alloy steel pin and which has been eccentrically turned so that it may be rotated and secured to hold the wheel tread in a common plane with all other wheel treads. Each wheel shall be allowed a lateral float on its pin and shall be provided with self-lubricating bronze thrust washers bearing against corrosion resistant surfaces. All wheels on each side of a gate shall, when centered, lie in a common plane parallel with the longitudinal gate and side seal centerlines. Pin eccentricity and wheel float shall not be less than as shown on the approved manufacturer's shop drawings. Gate design shall be such that any wheel may be dismounted, removed, and returned or replaced without further gate disassembly. Holes for wheel pins in supporting members of the gate shall be line bored, with all hole centerlines parallel and in a common plane.

Guide springs may be provided, if so needed, on the gate to prevent the movement or shifting of the gate by wave action or minor flow disturbances. The guide springs shall bear against a metal guide to maintain a moderate bearing pressure between the wheels and track. The springs shall be adjustable to obtain nearly uniform bearing between the wheels and track.

Gate seals shall be of natural or synthetic rubber or neoprene with side and top seals molded into music note shapes or J-type substantially as shown on the specification drawings. Seals shall be furnished in one piece

drilled and ready for installation or shall be furnished in not over eight pieces with necessary drills, cement and vulcanizing equipment for field fitting. The tensile strength of all splices shall be not less than 50 percent of the tensile strength of the unspliced material. Seals shall be so mounted that the centerlines of seal contact faces on a centered and closed gate shall coincide with the centerlines of the seal seat faces. Specially molded corner seals shall be provided for use at seal corners. Side and top seals shall be designed and assembled to tightly contact their seats normally. Side and top seals shall have sufficient strength and flexibility to project 1/4 inch beyond normal and to resist failure and extrusion, should unbalanced pressure be applied before they are opposite their seats and to return to normal setting when the pressure is equalized. All seals shall be mounted on machined plane surfaces. They shall be secured in place by bars and fastenings of corrosion-resistant metal. Fastenings may not be in the zones of seal and seat contact.

Each completely assembled fixed-wheel gate shall close readily by gravity with at least 33 percent excess of effective weight over frictional resistances under any conditions of reservoir water level, gate opening, and flow conditions, and shall be watertight between lines of seals.

2.1.3 Gate Frames and Guides

Gate frames provided for the regulating gate intake bellmouth shall each consist of a gate sill, wheel tracks mounted on bases and seal seats mounted on frames, and all fastenings, anchor bolts, and accessories required by the design. Heavy track bases designed to withstand maximum wheel loads shall extend, as a minimum, from the sill to an elevation above the bearing points for the top gate wheel with the gate in the normal raised position. Gate frames and bases, including sills will be installed in recesses in the primary concrete. Anchor bolts, placed with this concrete, will be used for subsequent securing and alignment of the parts prior to embedment in secondary concrete. Except as noted, parts may be structural or cast steel. Seal seats and sill shall be fabricated from corrosion-resistant stainless steel plates, and may be furnished as rolled if within the specified dimensional tolerances unless specially noted and except that abutting edges shall be ground to provide continuity without offsets. Tracks and all fastenings that will not be completely embedded also shall be fabricated from materials having corrosion-resisting properties. Tracks shall have the strength and hardness required to prevent permanent deformation under maximum wheel load, shall be finished for closely fitted seating in machined recesses in the bases and shall be provided with adequate fastenings. Wheel contact surfaces may be slightly crowned to prevent edge loading, and shall be tapered at their upper ends to properly engage the wheels. Each track, with the supporting base, may be fabricated in two lengths with milled close-fitting ends above the waterway section that provides an overlap of track on base of not less than 10 inches. Each track base shall be rigid enough to properly distribute wheel loads to the concrete of the structure under hydraulic unbalance. All embedded members shall be designed to facilitate field connection and alignment, and the filling of the formed recesses with secondary concrete. Holes shall be required in embedded frame members for reinforcing steel. Sills as installed shall be normal to the longitudinal gate axes and shall be firmly attached to the side frame members. Reinforcement bars shall be provided in the second stage concrete to withstand maximum diagonal shear stress in the concrete due to wheel loads.

Rolled steel or cast iron gate guides extending upward from the sill plates to the maintenance deck will be attached to the wheel track with adequate

welding. The guides with adequate stiffening reinforcement shall be extended a short distance above El. 520.0 to provide convenient insertion of the gates whenever they are lowered by crane. Guides shall be furnished in convenient spliced lengths, and shall be of such a shape that will not be seriously affected by corrosion and can be readily handled without distortion and that, when installed, can adequately withstand any probable combination of gate and wave forces. Faces of guides shall be smooth and free of offsets, and if necessary, shall be finished to meet this requirement.

2.1.4 Lifting Beam

Lifting beam shall have two hooks to engage the closure gate. The lifting beam shall be semi-automatic type of proven design. A counterweight actuated mechanism with manual lever can be used for such automatic operation. During lowering operation, the lifting beam shall automatically release the gate only after the gate rests fully on the sill under water. During raising operation, the lifting beam shall automatically grapple the closed gate under water. The lifting beam shall utilize the same gate frames and guides as provided for the emergency closure gates. All pins and axles for the hooks and guide rollers shall be of stainless steel with self lubricating bronze bushings. All fasteners used in assembling the lifting beam shall be of stainless steel. Bronze shoes are permitted on the guides as needed.

The wire ropes shall be of Type 316 stainless steel and shall have a safety factor of eight (8) based on breaking strength of rope.

Suitable lubrication provision shall be made for all hook pins and guide roller axles.

2.2 SPECIAL TOOLS TO BE FURNISHED

The Contractor shall furnish all special tools required for disassembly and maintenance of the equipment. In addition, a slugging wrench shall be furnished for the gate leaf nuts and spanner wrenches as needed. A complete list of special tools to be furnished by Contractor shall be included in the Bid.

2.3 SPARE PARTS

A set of spare parts as recommended by the manufacturer shall be supplied. All spare parts shall be duplicates of the original parts they are interned to replace. Each spare part shall bear a tag or label securely attached clearly identifying the component for which it is intended. Spare parts shall include but not be limited to:

1. One spare set of all rubber or neoprene seals and packings.

2. One spare set of used bushings.

3. One spare set of Type 316 stainless steel wire ropes.

4. Ten percent of all bolts and fasteners.

5. One spare set of storage chains and accessories.

PART 3 EXECUTION

3.1 SHOP ASSEMBLY AND TESTS

3.1.1 General

1. Each gate along with wheels and seals shall be completely shop assembled. All shop assemblies and tests specified below for the various items of equipment will be witnessed by a representative of the USACOE unless specifically waived in writing. Copies of all shop inspection records shall be furnished. No equipment shall be shipped from manufacturer's shops until it has been inspected or inspection has been waived in writing by the USACOE on an item-by-item basis. Prior to major shop assemblies and tests, the manufacturer shall submit for review an outline of the procedures and tests he plans to perform to demonstrate fulfillment of the requirements of the Specifications. The shop tests shall be based on the reviewed and approved procedures.

2. While being assembled, each item of equipment shall be checked for dimensions, tolerances, accuracy of alignment workmanship and compliance to approved drawings. Any deficiencies and deviations from the contract and/or approved drawings shall be corrected. All instruments and devices required during the inspection for the examination, measurement or testing of the equipment shall be provided and calibrated by the manufacturer.

3. Before disassembling and after installation of dowels and fitted bolts between bolted subassemblies, all parts shall be clearly matchmarked. Matchmark diagrams for field erection use shall be prepared and submitted to the Engineer.

4. The direct cost of all inspection trips by the USACOE's representatives shall be borne by the Contractor. A minimum of two 5-day inspection trips shall be assumed. The cost (round-trip air fare, per diem, lodging and car rental cost) shall assume Los Angeles as the departure point and the various locations of gate equipment manufacturing as the destination. Air travel shall be business-class travel with no restrictions and shall be by the most direct route possible. The estimated per diem shall be based at a minimum, upon information from the Federal Register Chapter 301, Travel Allowances, Appendix A, or similar guidelines for selected destinations. The cost of additional trips or longer duration trips resulting from poor scheduling, lack of preparedness, unforeseen conditions or non-conformance to contract requirements shall be at no additional cost to the Government. All travel arrangements shall be made by the Contractor and included in the bid at no cost to the Government.

3.1.2 Wheel Gate Embedded Parts

1. Each embedded frame, including sill beam, seal plates, track plates, bearing plates, and side members, shall be completely shop assembled and checked for correct fit and alignment. This may be done in either the vertical or horizontal position.

2. Other members of embedded parts shall be shop assembled in partial lengths successively joining their matching connections so that each field connection will be checked for assembly at least once.

3.1.3 Wheel Gate

1. The finished and painted wheel gate including seals, guiding

devices and all other applicable accessories shall be completely shop assembled. All field splices shall be assembled; welded field-splices shall be temporarily bolted for shop assembly.

2. All seals shall be fitted to their supports during the shop assembly and proper allowances shall be made for shrinkage after aging.

3. The assembled gate shall be lifted vertically and checked for plumbness within specified tolerances. The location of the ballast to attain required plumbness and the total weight of the gate shall be noted on the shop drawings.

3.1.4 Gate Wheel Testing

1. General. The Contractor shall perform destructive and nondestructive testing and laboratory testing of the gate wheels as outlined below. The destructive and nondestructive tests shall be witnessed by the Contracting Officer unless waived in writing.

2. Destructive Tests (DT). One wheel shall be randomly selected for destructive testing and examination. Testing shall include complete physical and chemical analyses and macroscopic and microscopic examination of the interior wheel material including evaluation of the molecular structure grain size, inter- granular formations and precipitates and all related characteristics indicative of proper formation for the specified type material.

3. Non-Destructive Testing (NDT). Each wheel shall be 100 percent ultrasonic examined (UT) after forging:

(a) wheel rims - crown and both sides,

(b) wheel hubs - both sides.

Each wheel shall be 100 percent dye penetrant examined (PT) after heat treatment and after final machining.

4. Macroscopic and Microscopic Examinations. Macroscopic and micro scopic examinations shall be performed on specimens removed after heat treatment from one wheel. the tests shall verify that the material structure is uniform and consistent with the type of material used for the wheels.

5. Hardness Testing. each wheel shall be hardness tested at four random locations on each crown and on both sides of the rim. Average hardness outside the design range will be cause for rejection.

3.1.5 Miscellaneous Items

All other items not specifically covered above and whose testing is critical prior to shipment shall be shop tested.

3.2 INSPECTION AND TESTING OF PAINT

3.2.1 General

Paint inspection and testing shall be done as discussed in the following paragraphs.

3.2.2 Before and During Painting

1. Temperature and humidity during application and curing as set forth in approved application procedures.

2. Surface cleanliness and anchor profile by visual methods as set forth in approved application procedures.

3. Curing times and conditions for curing as set forth in approved application procedures.

3.2.3 After Painting

1. Required film thickness as set forth in approved application procedures.

2. Holiday testing by wet sponge method. Coating shall be 100 percent holiday free.

3. Non-destructive adhesion testing per ASTM D 4541. Acceptance criteria shall be as recommended by paint supplier.

3.3 MARKING

All parts of each closure gate assembly shall be marked and match-marked for identification to facilitate field erection and, in addition, all parts of each assembly shall be marked for ready identification with the proper assembly and to show the relative position of the part in the assembly. A diagram of such marking shall be submitted for approval. All joints shall be shop fitted and match-marked before shipping.

3.4 FIELD TESTING

After installation of the bulkheads, with all accessories, a test for water tightness of the system shall be made using water jets under pressure with soap bubble solution. Operating one gate at a time, each gate shall be raised to the full open position up to storage position. The gate shall then be lowered to the closed position. After the completion of this test and each gate shall be operated through four cycles in all six openings. The leaf shall travel smoothly with no tendency to chatter through the entire range of the leaf travel. Any defects and problems shall be rectified by the manufacturer to the complete satisfaction of USACOE at Contractor's expense.

3.5 PAINTING

The gates, frames and lifting beams including storage facilities and accessories shall be dismantled as required and cleaned as specified on the drawings and in SECTION 09940: PAINTING HYDRAULIC STRUCTURES AND APPURTENANT WORKS before painting as follows: The non-embedded ferrous surfaces of the frames, storage facilities and air vents and the entire area of all gate leaves and lifting beams shall be painted according to paint system 4. Seals shall not be painted. The embedded surfaces of the frames shall not be painted. Stainless steel surfaces shall not be painted.

All unpainted finished surfaces exposed to the atmosphere during shipment shall be coated with a corrosion preventive compound in accordance with manufacturer's recommendations as approved by the Contracting Officer.

3.6 STORAGE

If the closure gates are assembled when shipped, the Contractor may store the assembled gates indoors or outdoors. The gates shall rest on timbers so that no part of the assembly is in contact with the ground. The frames, leaves, lifting beams and all accessories may be stored outdoors and shall rest on timber so that no part is in contact with the ground.

3.7 INSTALLATION

The gate members shall be erected in strict conformity with the match marks, taper pins and dowels used at the time of shop assembly. The parts shall be aligned with the taper pins and dowels and then bolted together. Two prints of the match marked drawings shall be shipped with the gates. The gate frames and storage latches shall be held rigidly in place, true to grade, line and height, until placing of the concrete is completed. The gate frame and seals surfaces shall be set and maintained so that no part of the sealing surfaces shall deviate from a vertical plumb plane by more than 0.010 inch provided that the deviation shall not exceed more than 0.002 inch per foot. During installation, all bolts shall be tightened by calibrated torque wrenches. The torque reading of wrenches shall be approved. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to retighten bolts which may have been loosened by the tightening of subsequent bolts, until all bolts are tightened to the prescribed amount. The outside surfaces of the gate frames, and other parts to be embedded in concrete shall be cleaned of all rust, grease and dirt before the concrete is placed. After installation, all gate frames, and similar parts shall be tested with a hammer to detect possible voids in adjacent concrete. Three-fourths-inch N.P.T. holes shall be drilled and tapped as needed if voids are detected. Voids shall be grouted and the grout holes shall be fitted with solid steel pipe plugs and ground smooth. Grouting pressures shall not exceed 50 psi. After all concreting and/or grouting operations have been completed, a survey shall be conducted to determine whether or not the above specified tolerances have been maintained. If the specified tolerances have not been maintained, such corrective action shall be taken as directed or approved by the Contracting Officer.

3.8 EQUIPMENT GUARANTEES

3.8.1 General

All guarantees and warranties, whether express or implied, of materials, equipment, or workmanship that are in favor of the Contractor and manufacturer shall be transferred and assigned to the purchaser at the completion of installation and testing of any equipment furnished under this contract, and before final payment is made for such equipment. The Contractor and manufacturer shall obtain the consent of any relevant manufacturer or supplier of material, equipment or workmanship to the transfer and assignment of such warranties and guarantees to the Contracting Officer. Such guarantees and warranties shall be in addition to those required of the Contractor and manufacturer by other provisions of these Contract Documents.

The Contractor and manufacturer shall, at the date of final inspection and acceptance, issue guarantees for all permanent equipment furnished by the Contractor and manufacturer under these contract Documents that they shall be free of all defects in design, workmanship and materials; that they shall meet each and every criterion and condition of these Contract

documents; and that they shall perform in accordance with any and all performance guarantees, as contained in the contract documents, or as given by the Contractor and manufacturer, which guarantees shall be effective for 5 years from the date of final inspection and acceptance.

3.8.2 Failure to Meet Guarantees

Should any of the equipment fail to meet the guarantees or other requirements of the Contract Documents within the time covered by the guarantees, the Purchaser may direct the Contractor and manufacturer to proceed at once to make alterations or furnish new parts as may be necessary to meet the requirements. All expenses of furnishing, delivering, and installing new parts, or making alterations to existing parts, and of tests made necessary by failure of the equipment to meet the guarantees and other requirements for the Contract Document shall be borne by the Contractor and manufacturer. If, after due notice, the Contractor and manufacturer shall refuse to correct any failure of the equipment to meet the requirements of the Contract Documents during the guarantee period, the purchaser may proceed at its own expense to correct such failure and to collect from the contractor and manufacturer an amount equal to the actual expense so incurred, including overhead and all other incidental expenses. This remedy of the purchaser is in addition to any and all other remedies provided for in the Contract Documents, or as provided for by law or equity.

3.9 SERVICES OF ERECTION ENGINEER(S)

The emergency closure gate supplier shall be required to provide one or more competent erection engineer who shall supervise and be responsible for the correctness of the contractor's assembly procedures, method of alignment, installation of equipment and testing. When so requested, he shall also supervise and be responsible for initial starting and all subsequent operation of the equipment until the field tests are completed. The erection engineer shall instruct the Contracting Officer for a minimum of one full day, in the operation and maintenance features of the equipment. The erection engineer shall cooperate fully with the Contractor, however, the work and operation of the manufacturer's representative shall be directed by the Contracting Officer. The Contracting Officer shall be given 30 calendar days advance notice of the time when such services of the manufacturer's representative shall be needed and the Contractor shall be held responsible for any work done in the absence of the manufacturer's representative. Any errors in work done in the absence of the erection engineer, or work which does not conform to the instructions issued by the manufacturer, shall be corrected.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15096

MAINTENANCE BULKHEAD FOR LOW FLOW OUTLETS

-- End of Section Table of Contents --

SECTION 15096

MAINTENANCE BULKHEAD FOR LOW FLOW OUTLETS

PART 1 GENERAL

1.1 GENERAL INFORMATION

This section covers all work including designing, furnishing, installing and testing one (1) 4-foot by 4-foot Maintenance Bulkhead with one lifting (pick up) beam, and two (2) sets of gate frames, guides, seal seats, storage facilities and accessories for the low flow outlets of Prado Dam Low Flow Outlets.

The bulkhead is intended to be normally stored in a suspended position above any of the two low flow outlet intakes by means of the storage facilities provided above in each intake as shown on the drawings. The bulkhead will be picked up with the help of lifting beam from the storage position by means of a mobile crane from the deck at El. 520.0 and lowered under fairly balanced water pressure conditions to shut off flow for maintenance by closing the entrance of any of the intakes as may be needed. The gate will be normally raised under fairly balanced water pressure.

The Contractor shall design all components of the gates, frames and lifting beam and accessories to safely withstand maximum forces during the bulkhead operation and shall determine the crane capacity required.

1.2 MANUFACTURER PREQUALIFICATION

The bulkhead, frames, lifting beam, and all other associated elements shall be the product of a manufacturer regularly engaged in the design and fabrication of water flow shut off gates of similar size and rating. The manufacturer shall submit documentation demonstrating experience in successful design, fabrication, installation and operation of comparable size bulkheads and lifting beam.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent applicable.

1. AISC Manual for Steel Construction - Allowable Stress Design (1989).

2. USACOE Manual EM 1110-2-2105, Design of Hydraulic Steel Structures.

3. Design Guidelines for High Head Gates - ASCE Hydro Gates Task Committee (Journal of Hydraulic Division, December 1955).

4. Handbook of Applied Hydraulics, Davis and Sorensen, Third Edition (1984).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B46.1	(1985) Surface Texture
ANSI Y14.5	(1994) Dimensioning and Tolerancing

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M	(1998a) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 276	(1998) Stainless Steel Bars and Shapes
ASTM A 564	(1995) Hot-Rolled and Cold-Finished Age-Hardening Stainless and Heat-Resisting Steel Bars and Shapes
ASTM D 395	(1989; R 1994) Rubber Property - Compression Set
ASTM D 412	(1998; Rev. A) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 413	(1982; R 1993) Rubber Property - Adhesion to Flexible Substrate
ASTM D 471	(1996) Rubber Property - Effect of Liquids
ASTM D 572	(1988; R 1994) Rubber - Deterioration by Heat and Oxygen
ASTM D 2240	(1997e1) Rubber Property - Durometer Hardness
ASTM D 3951	(1995) Practice for Commercial Packaging
ASTM D 4541	(1995) Pull-Off Strength of Coatings Using Portable Adhesion Testers

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Steel

FEDERAL SPECIFICATIONS (FS)

FS RR-W-410C	(1988) Corrosion Resistant Steel For Wire Ropes

1.4 SPECIFICATION DRAWINGS

The specification drawings indicate the general arrangement, clearances (necessitated by structure and other equipment), maximum overall dimensions and other suggested pertinent features. The Contractor shall be entirely

responsible for all design and shall prepare designs and shop drawings in conformity with the specifications and design and Performance Requirements included in the solicitation. The Contractor shall submit design calculations, shop drawings and catalog data for approval prior to manufacture. The dimensions of welds and other sizes or dimensions of structural members indicated on the specification drawings as minimum are intended to be minimums.

1.5 DESIGN AND PERFORMANCE REQUIREMENTS

1.5.1 General

The Contractor shall design in conformity with these specifications and references listed in paragraph: REFERENCES as applicable and the following design criteria.

1.5.2 Design Parameters

1.5.2.1 Design Data

Gate Sill Elevation	470.0
Operational Design Head	50 Feet Measured from Gate Sill
Nominal Width of Bulkhead	4 Feet 0 Inches
Nominal Height of Bulkhead	4 Feet 0 Inches
Type of Gate	Sliding Type
Type of Hoist	Mobile Crane
Hydrostatic Design Head	96 Feet from the Gate Sill

1.5.2.2 Bulkhead Design

The bulkhead shall be designed to be suitable for satisfactory and reliable closure under gravity without vibrations, cavitation, oscillations or seizing or galling problems under balanced head up to a maximum of 50 feet above the gate sill. The bulkhead will be normally raised under fairly balanced pressure condition.

1.5.2.3 Gate Deflection

The maximum allowable deflection of the bulkhead shall be less than 1/1,000 of the span.

1.5.2.4 Loading Conditions

The equipment shall be designed to withstand stresses during static as well as operational conditions corresponding to the loading conditions as stated below:

Normal Load Condition: Hydrostatic head of 96 feet from (above) bulkhead sills

Overload Condition: Hydrostatic head of 96 feet above bulkhead sill plus the loadings included as determined for earthquake forces.

For materials and stresses not covered by USCOE Engineering Manual EM-1110-2-2105, the allowable stresses for normal loading condition shall be the normal design stresses defined above. The allowable stresses for the overload condition shall not exceed the normal design stresses by more than 33-1/3 percent or 0.75 of the yield stresses of the materials, whichever is lower.

1.5.2.5 Earthquake Forces

Earthquake forces shall be accounted for in the design as determined in accordance with Section 13080 of these specifications.

1.5.3 Allowable Stresses

The allowable stresses shall be as specified in EM-1110-2-2105, U.S. Army Corps of Engineers Manual for Design of Hydraulic Steel Structures. When stress conditions and materials are not covered in EM 1110-2-2105, the following shall govern:

1. For tensile and compression stresses, the smaller of the values given below shall be allowed:

(a) For rolled, forged or stainless steel, the tensile and compression stresses shall not exceed 40 percent of yield point or 25 percent of ultimate strength or 16,200 psi, whichever is lower.

(b) For rolled or forged steel bolts, the maximum tensile or compression stresses shall be limited to 25 percent of yield point or 16.5 percent of ultimate strength, whichever is lower.

(c) For cast steel, the maximum tensile and compression stresses shall be limited to 33 percent f yield point or 20 percent of ultimate strength, whichever is lower.

(d) For cast iron, the maximum tensile strength shall be not greater than 165 percent of ultimate strength.

(e) For brass or bronze, the maximum tensile and compressive stress shall not exceed 33 percent of yield point or 16.5 percent of ultimate strength, which ever is lower.

2. For shear, the maximum stress shall be less than 0.6 times the allowable tensile stress, except for cast iron, the permissible shear stress shall be equal to the allowable tensile stress.

3. A corrosion allowance of 1/16 inch for structural steel members subject to submergence shall be made.

4. The coefficient of friction between teflon clad rubber seal and stainless steel shall be assumed as 0.20.

5. Loads on bearing plates shall be calculated assuming uniform load distribution and with the normal or overloads loads acting on the bulkhead structure. The bearing track plate shall be mounted to the embedded backing plate by welding. The thickness of the track plate shall be adequate not only for structural strength but also to ensure that the concrete underneath can safely withstand the stresses induced. The CONTRACTOR shall submit detailed calculations to verify the stresses.

6. The allowable stresses in all anchor bolts, bearings or other standard manufactured products shall not exceed 90 percent of the values recommended in the manufacturer's catalogues. Lower allowable stresses shall be utilized wherever these are subjected to vibrations and dynamic loads.

7. Embedded parts in the concrete structure and parts bearing on the concrete structure shall be designed for water load equal to maximum design head or wind loads as applicable together with dead and live loads from the gates, in accordance with the requirements of ACI 318 and based on a concrete 28-day compressive strength of 4,000 psi. A load factor of 1.7 shall be used for all water loads, and the combined factor dead and live loads shall be multiplied by a "Hydraulic Structural Factor", Hf = 1.3, to compute the required strength, U. When loads from earthquake, overload operating forces, or wind are included, Hf shall be multiplied by 0.75.

1.5.4 Operating Forces

1.5.4.1 Force Components

a. General. For calculating the operating loads, either the maximum or minimum value shall be applied to each one of the force components, so that the most conservative results are obtained. It shall normally be assumed that force components act symmetrically except if the design is asymmetrical.

b. Weight. The nominal gate weight component shall include the weight of the ballast (if any), weight of all bulkhead-mounted equipment including the components connecting the bulkhead to crane, and the weight of trapped water, as applicable. The maximum weight of gate shall include weight of silt in the gate members exposed to silt accumulation.

c. Buoyancy. The nominal buoyance shall be calculated using the volume of the gate including ballast and any other gate-mounted equipment. The maximum buoyancy shall be calculated with specific gravity of water 1.1 to allow for silt.

d. Hydrostatic Effects. Nominal magnitude of hydrostatic effects shall be calculated using the design geometry of the part or detail under such effect and the applicable hydrostatic pressures. Hydrostatic loads shall be calculated with a specific weight of 62.5 pounds per cubic foot for fresh water.

e. Friction Forces.

1. General. Maximum friction forces shall be calculated using maximum normal fores and maximum friction coefficients. Minimum friction forces shall be calculated using minimum normal forces and minimum friction coefficients. A differential pressure of 5 psi shall be assumed on the bulkhead during operation to account for possible leakage through the valves.

2. Seal Friction Force. The seal friction force shall be calculated by summing the friction caused by the hydrostatic water load acting on the seal and the seal pre-compression force. The pre-compression force shall be used as given by the seal manufacturer or if such data are not available, pre- compression forces shall be determined by tests made by

the Contractor. The following seal friction coefficient shall be used, based upon conservative engineering practices.

Index	Maximum	Minimum
Rubber on steel	1.0	0.3
Rubber on corrosion-resistant steel	0.8	0.2
Fluoro-carbon on corrosion-resistant steel	0.15	0.05
Bronze on corrosion-resistant steel	0.5	0.15

3. Sliding Friction Forces. Sliding friction forces for gates and guide shoes shall be calculated using the following minimum and maximum friction coefficients:

Item	Maximum	Minimum
Corrosion-resistant steel on carbon steel, non-lubricated	0.5	0.1
Corrosion-resistant steel on corrosion-resistant steel	0.18	0.08
Corrosion-resistant steel on corrosion-resistant steel	Not Acceptable	
Bronze on corrosion-resistant steel, non-lubricated	0.4	0.1
Bronze on corrosion-resistant steel, lubricated	0.2	0.07
Self-lubricating bearing on corrosion-resistant steel	0.2	0.06

f. Guiding Device Friction. Friction forces shall be calculated using the average operating load on the guiding device and the applicable maximum and minimum friction coefficients.

g. Bottom Seal Compression Force.

1. Bottom seal compression force shall be calculated by dividing the sill reaction due to the nominal weight of the gate minus the maximum frictional forces and the buoyancy, when the gate is nearly closed, by the length of the bottom seal.

$$\text{Compression Force} = \frac{\text{Nominal Gate Weight - Maximum Frictional Forces - Buoyancy}}{\text{Bottom Seal Length in Feet}}$$

2. Bottom seal compression force shall not be less than 250 pounds per foot length of seal.

h. Loading on Guiding System.

1. General

(a) The loads specified below shall be used for designing the embedded guiding devices with their anchorage as well as gate-mounted guiding devices with their anchoring and supporting structures including all affected gate parts; they shall also be used for defining force components to be used in operating loading combinations.

(b) Loads that do not cause rotation of the gate shall be considered acting evenly distributed among all participating guding devices of a rigid gate. Reactions to loads causing rotation in the plane of a rigid gate shall originate only at the upper guiding device on one side and at the lowest guiding device of the opposite side. Tractions causing twisting moment around a horizontal axis in the plane of a rigid gate shall originate only at the upper pair and at the lowest pair of guiding devices.

(c) Forces and reactions on each guiding device shall be considered uniformly distributed over the design contact area. Minimum engagement shall be considered for defining the design contact area.

(d) For guide rail design, the guiding device shall be considered located both at a guide rail anchorage and also in between a pair of anchorages except for loading conditions corresponding only to a definite position such as for closed or dogged gate section.

2. Loads of Static Origin.

(a) Loads caused by the geometry, eccentricity of weights and forces, and similar effects related to the arrangement of the equipment shall be determined by customary force calculations. These loads shall correspond to effects such as the following:

(1) direction of pull outside the plan of guides and

(2) seating plane of the closed gate off the plane of center of gravity.

(b) Other loads of static origin such as precompression of seals, reverse water loading, and similar effects shall also be considered.

3. Guiding Effort and Water Turbulence.

(a) When the gate is not submerged, the guiding effort required to counteract the tendency of gate swinging shall be considered as at least 5 percent of the weight or a surface loading of 4 pounds per square foot, whichever is higher, in either horizontal direction. The gate area to be considered in either direction shall be the projected area of the gate outline.

(b) Effects of water turbulence for all locations where the gate is partially or fully submerged shall be computed on the basis of 20 pounds per square foot differential water load acting on the projected area of the gate outline.

4. Unsymmetrical Resistance to Operation.

(a) General. Forces parallel to the bulkhead movement and horizontal forces in the plane of the gate due to rotation shall be considered in the manner listed below.

(b) Normal Blocking Load in Lowering. Bulkhead moving downward and stopped by a resistance ("blocking force") at one lower fixed

guiding device at one guide. Acting forces shall be the average acting weights of bulkhead and accessories. The acting forces will be partially balanced by the friction forces originated at the two guiding devices receiving horizontal reactions; the remainder of the acting forces shall be balanced by the "blocking force".

(c) Extraordinary Blocking Load in Lowering. This loading condition shall be determined as for the "Normal Blocking Load in Lowering", except that the maximum downward forces shall be used rather than the average acting weight.

(d) Normal Blocking Load in Raising. Bulkhead moving upward and stopped by a resistance ("blocking force") at one upper guiding device at one guide. Acting force shall be the rated pull capacity of the hoist less the weight of the gate. The acting force shall be partially balanced by the friction forces originated at the two guiding devices receiving horizontal reactions; the remainder of the acting forces shall be balanced by the "blocking force".

(e) Extraordinary Blocking Load in Raising. This loading condition shall be determined as for the "Normal Blocking Load in Raising", except that the maximum pull capacity of the hoist shall be used rather than the rated capacity.

5. Earthquake Loading. Earthquake forces shall be determined in accordance with Section 13080 of these Specifications.

6. Normal Loading Combinations. Normal loading on guiding devices shall be obtained by combining the following loads wherever applicable:

(a) Loads of static origin.

(b) Loads due to guiding effort.

(c) Normal blocking loads.

7. Overload Combinations. Overload combinations on guiding devices shall be obtained by either one of the following summations of applicable loads:

(a) Loads of static origin, loads due to guiding effort and water turbulence, and extraordinary blocking load in raising or lowering.

(b) Loads of static origin and loads due to guiding effort.

(c) Loads of static origin combined with earthquake loading.

1.5.4.2 Combination of Force Components.

a. Force components shall be combined according to Table 1, "Force Combination Cases", to establish the required operating forces.

b. Where all force components act parallel to each other and the hoist pull, Table 1, "Force Combination Cases", shall be used directly. Where force components are not parallel to each other and to the hoist pull, the moments (around the axis of rotation) caused by the force components shall

be used.

TABLE 1
FORCE COMBINATION CASES

Application Force Components	Force Combination Cases I Safety of Closure	II Normal Pull	III Forces on Crane During Lowering Operation
Weight	+ 0.95 Nom.	+ 1.05 Max.	+ 1.05 Max.
Buoyancy	-1.05 Max.	- 0.95 Nom.	- 0.95 Nom.
Seal and Guide Friction	- 1.3 Max.	+ 1.3 Max.	- 0.8 Min.

1.5.5 Materials

The following materials and material specifications shall be used. If the bidder intends to substitute any of the materials, he should clearly state so in this bid and the reasons for substitution. He shall submit the specifications for such alternative materials.

1. Leaf, frames, guides, and lifting beams shall be of structural steel conforming to ASTM A 36/A 36M.

2. Gate seal seats shall be of stainless steel conforming to ASTM A 276, Type 316.

3. Wheel Track shall be of stainless steel conforming to ASTM A 564 Type 630.

4. Guide rollers shall be of stainless steel conforming to ASTM A 564, Type 630.

5. Wheel pins shall be of stainless steel conforming to ASTM A 276, Type 316.

6. Seal fasteners shall be of stainless steel conforming to ASTM A 276, Type 316.

7. Wire ropes shall be of corrosion resistant steel conforming to FS RR-W-410C, 1WRC.

8. Wire rope fittings shall be of corrosion resistant steel components conforming to Manufacturer's Standards.

9. Lubricating fittings shall be Alemite, Type A-1188 or A-1184, as manufactured by Alemite division of Stewart Warner Corp., 1826 West Diversey Parkway, Chicago, IL 60614, or equal.

10. Grout for machinery shall be non-shrink epoxy grout.

11. Fluoro-carbon (PTFE) bushings and washers shall be "Rulon A" as manufactured by the Dixon Industries Corporation, Bristol, RI 02809, or equal.

12. High strength fiber-reinforced phenolic bearing material shall be "ORKOT TLM" as manufactured by ORKOT Engineering Plastics, 2535 Prairie Road, Unit D, Eugene, Oregon 97402, or equal.

13. Neoprene seals shall be molded of neoprene compound or copolymer of butadiene and styrene or a blend of both. The compound shall contain not less than 70 percent by volume of the basic polymer, and the remainder shall consist of reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers conforming to tensile strength 3,000 psi - ASTM D 412, elongation at break 450%, water absorption by weight 5 percent - ASTM D 471, compression set 30 % of original - ASTM D 395.

14. Fluoro-carbon clad rubber seals shall be as specified above. A fluorocarbon sheath shall be bonded to the rubber on the sealing surface. The sheath shall be abrasion resistant Fluoro-Carbon Film No. 4508 as manufactured by Buckhorn, Inc., 55 West Technecenter Drive, Milford, OH 45150, or equal. The outside surface of the fluoro-carbon sheath shall be free of adhering or bonded rubber conforming to ASTM D 412, ASTM D 2240, ASTM D 471, ASTM D 395, ASTM D 572 and ASTM D 413 (friction test).

1.5.6 Anchors and Alignment Provisions

The Contractor shall be responsible to design and provide adequate number of anchors welded to the gate frames. These frames, together with anchors, should be designed for external water load equal to the maximum pool pressure. External tension anchors shall transfer the water load to the concrete by compression and/or bearing and shall prevent the gate frames from collapsing inward if leakage occurs around them. The allowable tensile and bending stresses in the structural steel members and anchors shall not exceed 16,200 pounds per square inch.

The Contractor shall also provide adequate alignment anchors with turnbuckles to permit precise alignment of the gate frames. Provisions such as seats welded to frames for hydraulic jacks and other erection tackle shall be made.

1.5.7 Surface Roughness and Finish

The Contractor shall indicate on his submittal drawings the surface roughness. The Contractor shall indicate on his submittal drawings the surface roughness specified by numbers in check-type marks on the surfaces, which shall be machine finished and shall conform to the surface quality specified in ANSI B46.1, entitled, "Surface Texture", published by ANSI.specified by numbers in check-type marks on the surfaces, which shall be machine finished and shall conform to the surface quality specified in ANSI B46.1, entitled, "Surface Texture", published by ANSI.

1.5.8 Tests of Materials

1.5.8.1 General

All materials or parts used in the equipment shall be tested, unless otherwise directed, in conformity with applicable methods prescribed by the ASTM, or such other organizations as may be specifically required, and in general accordance with the best commercial methods. When requested, tests shall be made in the presence of the Contracting Officer. Stocked material may be used provided evidence is furnished showing that such material meets

the specified requirement, in which case tests on stocked material may be waived.

1.5.8.2 Test Reports

Certified material test reports shall be furnished. The test reports shall identify the component for which the material is to be used and shall contain all information necessary to verify compliance with the Specifications.

1.5.9 Workmanship

1.5.9.1 General

a. All work shall be performed and completed in a thorough workmanlike manner and shall follow the best modern practices in the design and manufacture of gates and hoists. All work shall be done by personnel skilled in the related professions and trades. All parts shall be made accurately to standard so as to facilitate replacement and repairs. All bolts, nuts, screws, rivets, threads, pipe, gages, gears and measurements or dimensions shown on the shop drawings approved by the Contracting Officer shall conform to the standards specified under References. Dial special gages and templates necessary for field erection of the wheel gate shall become the property of the Government.

b. Like parts and spare parts shall be interchangeable wherever possible. Machining of fits on renewable parts shall be accurate and to specified dimensions so that replacements made to the size shown on the shop drawings may be readily installed.

c. The design and fabrication of the equipment shall provide for adequate adjustment by the use of shim plates, oversized holes, or other suitable means so that there are minimal interfacing difficulties during erection.

1.5.9.2 Welding

a. General. All welds shall be continuous and watertight. All welding shall be performed by the electric-arc method, by a process that excludes the atmosphere from the molten metal, and where practicable, by automatic machines. Machined surfaces of parts affected by welding shall be machined to final dimensions after welding. Machined surfaces of parts requiring stress relief shall be machined to final dimensions after the parts have been stress relieved. Localized stress relieving will not be permitted for shop welded parts.

b. Minimum Weld Requirements. All welds shall be made continuous and watertight. The minimum size of fillet welds shall be 1/4 inch measured on the leg except if otherwise specified. Welds larger than 5/16 inch shall be made in not less than 2 passes. All groove welds including butt welds shall be full penetration, welded from both sides.

c. Preparation of Base Material. Members to be joined by welding shall be cut to shape and size by mechanical means such as shearing, machining, grinding, or by gas or arc cutting, to suit the conduits. The design of welded joints and the selection of weld filler metal shall allow thorough penetration and good fusion of the weld with the base metal. The edges of surfaces (up to the thickness of the metal) to be welded shall be sound metal free of visible defects, such as laminations or defects caused by cutting operations, and free from rust, oil, grease, and other foreign

matters.

d. Technique of Welding. The technique of welding, the appearance and quality of the welds, and the methods used in correcting defective work shall conform to the AWS D1.1. Special care shall be taken to avoid undercuts along the seams or warping of the structure. If undercuts appear along the welds, they shall be filled using a small diameter electrode of the same composition as the original electrode after slag, if any, is removed. Continuous and uniform maintenance of preheat and interpass temperatures will be required for all welds. Local preheating shall be used only for repairs on welds. Preheat and interpass temperature shall also be as outlined in the welding procedure according to the applicable sections of AWS D1.1 or ASME Code, Division 1.

e. Welding Qualifications. The qualification of welding procedures, welders, welding operators, and tackers shall conform to standards at least equal to Section 5, "Qualification" of AWS D1.1. The Contractor shall furnish all facilities and all equipment, materials, and other articles required to conduct qualification tests of his welders and welding operators. Certificates of welders' qualifications shall be submitted when requested.

f. Weld Finish. Welds shall, in general, be treated so that they will display good appearance and a surface suitable for painting. Structural welds shall be ground and blended to avoid stress raisers. All welds which require nondestructive examinations shall be dressed by chipping and grinding as required for good interpretation by the selected weld examination methods.

g. Environmental Requirements. Recommendations of the ASME Code, Section VIII, Division 1, Paragraph UW-30, shall be observed for temperature and weather conditions for welding.

1.5.9.3 Castings

a. General. Castings shall be free from injurious defects and shall be satisfactorily cleaned for their intended use. All bronze castings for bushings and bearings shall be centrifugally cast unless approved otherwise. Surfaces of castings which are not machined shall be dressed for good appearance and for painting. The location of existing defects shall be determined, and all defects which impair the strength or utility of the casting shall be removed to sound metal before repair. The structure of the castings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in the casting will be cause for its rejection.

b. Repair Welding. Minor defects that shall not impair the strength or serviceability of the castings may be repaired by welding in accordance with accepted foundry practice without review by the Contracting Officer. Defects shall be considered minor when the depth of cavity properly prepared for welding is not greater than 25 percent of the actual wall thickness but in no case greater than 3/4 inch and when the area to be welded is smaller than 8 in2. However, an accumulation of minor defects which, in the opinion of the Contracting Officer, casts doubt as to the general quality of the casting shall be considered as a major defect. A complete descriptive report of major defects, supplemented with sketches, photographs, and metallurgical test reports, as the case may warrant, and the proposed repair procedure shall be submitted for review prior to any

repair of major defects. If removal of defects reduces the stress-resisting cross-section of the casting by more than 30 percent, the casting may be rejected. All castings repaired by welding of major defects after heat treatment shall be heat treated again.

1.5.9.4 Nondestructive Testing

a. General. Unless otherwise indicated, all nondestructive tests shall be in accordance with the applicable sections of ASTM Volume 03.03. The shop drawings shall define the areas, extent and type of nondestructive examinations to be employed. Personnel who perform or interpret nondestructive tests shall be qualified in accordance with ASNT Recommended Practices No. SNT-TC-1A 1988 Edition # 2045, Level II or III.

b. Examination of Welds. All critical welds, including all welds on primary structural components, shall be given complete nondestructive examination by radiographic, ultrasonic, magnetic particle, or dye-penetrant methods, as applicable or specified, throughout the entire length. Full penetration welds shall be given nondestructive examination throughout their entire length by radiographic examination. Where radiographic examination is not feasible or results are likely to be doubtful, ultrasonic supplemented by magnetic particle or liquid penetrant methods shall be used. All welds (100 percent) shall be inspected visually throughout their entire length. The Contracting Officer shall have the right to request random spot-check examination of welds, including radiographic examination, as part of the equipment inspection. Examination of welds shall be in accordance with the technique and acceptance standards of Section VIII, Division 1, of the ASME Code. Ultrasonic examination shall meet the technique and acceptance standards as defined by ASME Code, Section VIII, Appendix 12. Radiographic examination shall meet the technique and acceptance standards of Paragraph UW51, Section VIII, Division 1, of the ASME Code. Magnetic particle and liquid penetrant examination shall meet the technique and acceptance standards as defined by ASME Code, Section VIII, Division 1, Appendices 6 and 8, respectively. Where stress relieving is required, nondestructive examination shall be performed after stress relieving.

c. Examination of Castings

1. Castings for major components shall be given a complete ultrasonic examination and a radiographic examination insofar as practicable. No casting will be accepted having defects larger than those indicated under (14.13), C.2. Repair Welding, above. Where radiographic examination is not practicable due to configuration or accessibility, other nondestructive examination, subject to the Engineer's review, may be substituted.

2. Inspection. Castings shall be inspected visually at the foundry after they are cleaned and while defects are being removed. Castings shall also be inspected after repairs and after heat treatment. Radiographic or other nondestructive tests will be required as specified and as directed when permission is granted to repair major defects. The Contracting Officer shall have the right to require nondestructive tests at the Contractor's expense to determine:

(a) The full extent of defects.

(b) That the area is properly prepared for welding.

(c) That the repairs are satisfactory.

d. Examination of Forgings. Major forgings shall be given ultrasonic examination with liberal overlap and other applicable nondestructive tests, to determine that they are sound. Nondestructive examination of minor forgings shall be in accordance with accepted good practice to assure their soundness. The structure of forgings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a forging will be cause for its rejection.

1.5.9.5 Machine Work

a. General. Sufficient machining stock shall be allowed on all parts to be machined to ensure true finished surfaces of solid material.

b. Finished Surfaces. In addition to the machined surfaces indicated on the specification drawings, all surfaces that require machining for their intended function and those surfaces that are normally machined in good shop practice shall be machined. Finished contact or bearing surfaces shall be true and exact to secure full contact. Journal and sliding surfaces shall be polished and all surfaces shall be finished with sufficient smoothness and accuracy to insure proper operation when assembled. No machining shall be done on working surfaces of self-lubricating bushings or washers. Corrosion-resistant-steel, seal plate surfaces in contact with seals shall be thoroughly cleaned and machined to have a smooth and even surface.

c. Pins and Pin Holes. Pin holes shall be drilled smooth and straight and at right angles to the axis of the member. The drilling shall be done after the member is securely fastened in position and shall be line bored in one set-up where practicable.

d. Unfinished Surfaces. All work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the specification drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in an approved manner.

e. Assembly. Before assembly, all bearing surfaces, journals and grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. After assembly, each lubricating system shall be filled with an approved lubricant. Self-lubricating bearings shall be treated according to the manufacturer's instructions.

1.5.9.6 Tolerances

a. General. All tolerances shall be selected to correspond to the accuracy required for the proper operation of the equipment considering the nature and function of the part. Plate thicknesses shall be governed by ASTM A 6/A 6M.

b. Designations. Tolerances shown on the specification drawings and specified elsewhere in these Specifications have been designated as follows: dimensional tolerances for cylindrical parts in the ISO system,

position and form tolerances in accordance with ANSI Y14.5, and surface finish designations in accordance with ANSI B46.1. Surface finish designations are in microinches as determined by the root-mean-square (RMS) method. The Contractor shall use these same standards for symbols and designations, or shall submit with the first review shop drawings alternative designation codes and their correspondence with the specified standards.

c. Selection

1. General. The tolerances specified in these Specifications and on the specification drawings are maximum tolerances applicable to the equipment when it is installed. Finer shop tolerances shall be established, if necessary, to meet the specified design or operational requirements or for interchangeability of spare parts. All tolerances shall be selected with due consideration to the nature and function of the parts, to the effects of cumulative tolerances and to the corresponding accuracy required to secure proper operation, but they shall not exceed the tolerances specified below.

2. Bulkhead

(a) Skinplate. Bottom and top edge of the skinplate of the bulkhead section shall be parallel within ± 0.010 inch per 5 feet of height. Length of diagonals connecting skinplate corners shall be within ± 0.003 inch for any 5 feet of skinplate perimeter but in no event shall exceed ± 1/4 inch of nominal dimensions. Bottom of the skinplate and the top of the skinplate shall be straight within ± 0.050 inch over any 10 feet of length and ± 0.010 inch over any 5 feet of length.

(b) Seal Seat Bars. Seal seat bars for side seals shall be within 1/16 inch of a plane parallel to the rolling surface of the wheels. Seal seat bars for top seals shall not have more than 0.050 inch of camber over any ten feet of length, or 0.010 inch of camber over any five feet of length. The maximum total camber over the entire span shall not exceed 0.060 inch.

(c) Plumbness. The assembled gate when hung vertically from its lifting lug (point of connection with the hoist bottom most rod extension) shall be plumb within ± 1/4 inch to a horizontal axis and within ± 1/16 inch to a vertical axis.

3. Embedded Parts

(a) Sealing Surfaces. Each embedded sealing surface shall be within ± 0.050 inch of the design plane along its length and ± 0.010 inch across its width.

(b) Tracks. Upstream as well as downstream tracks shall be within ± 0.050 inch of the design plane along their length and ± 0.005 inch across their width. Tracks shall be checked for straightness by means of a ten foot (minimum length) straight edge and feeler gages and shall be straight within ± 0.01 inch over any 10-foot length or ± 0.002 inch over any 5-foot length. Sudden steps on track surfaces shall be not more than 0.001 inch high. Track plates shall be parallel across the opening within ± 0.0050 inch. The distance in the flow direction between the upstream and downstream track plates shall be within ± 0.050 inch.

(c) Sealing Frame

(1) Side and top seal places shall be in the same plane within ± 0.050 inch.

(2) Sill beam shall be in the design plane and within ± 0.050 inch. Centerline of the sill beam shall be perpendicular to the side and top seal plates plane within ± 0.050 inch.

(3) Length of diagonals connecting interior corners of the assembled sealing frame shall be within ± 0.003 inch for any 5 feet of seal perimeter but in no event shall exceed ± 1/4 inch of design dimensions.

(d) Guides. All guiding surfaces of each guide shall be straight within ± 0.050 inch over any 10-foot length. All guides shall be parallel with their opposite guide across the opening within ± 0.125 inch.

1.6 DESIGN CRITERIA

1.6.1 Function

All equipment and components shall be suitable for performing safely its intended functions as described in these Specifications and Contract Documents.

1.6.2 Features Shown on the Plans

a. General Arrangement. The general arrangement of the equipment shall conform to the Plans.

b. Mandatory Features. Mandatory features shown on the specification drawings shall be adopted without substantial change or substitution. Alternative arrangements and alternatives for mandatory features will be accepted only if in the judgement of the Contracting Officer the result is not inferior to that of the arrangement and details shown on the specification drawings. Mandatory features shall be the following dimensions, elevations, tolerances, other data or aspects:

1. All features referring to related work, such as civil work outline and dimensions of equipment.

2. All elevations, except if designated as "approximate" or "subject to variations".

3. The general layout and arrangement of the equipment and its major parts, including the dimensions defining location of the equipment relative to the civil work.

4. Dimensions, clearances, etc. designated by "maximum", "minimum" to be applied as upper or lower limit for the design.

5. All reference to the use of a specific material or a specific group of materials.

1.7 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G

Shop drawings and catalog cuts for Contractor-designed details.

All drawings submitted by the Contractor shall have the Contractor's title and drawing number on each drawing. Drawings and data shall show the specifications number. All dimensions shall be in feet and inches and all wording, signs, symbols, etc. shall be in English.

Approval Drawings and Data. As soon as practicable after date of award and before proceeding with fabrication or procurement of material, the Contractor shall submit to the Contracting Officer for approval, complete sets of shop drawings, material specifications design calculations, and commercial products data. Drawings shall conform to the requirements. Any fabrication or procurement performed, or shipment made, prior to approval of the drawings and data, shall be at the Contractor's risk. The Contracting Officer shall have the right to require the Contractor to make any changes in the equipment design which the Contracting Officer determines necessary to make the equipment conform to the requirements of these specifications without additional cost to the Government. Approval by the Contracting Officer of the Contractor's drawings or data shall not be held to relieve the Contractor of any part of the Contractor's responsibility to meet all of the requirements of these specifications or of the responsibility for the correctness of the Contractor's designs and drawings.

Where approval data are required for commercial products or equipment, the Contractor shall submit complete identifying data giving the manufacturer's name, type model, size, and characteristics of the equipment. When a catalog sheet is submitted, the particular item proposed shall be underlined or marked. The data shall be comprehensive and shall fully demonstrate that all equipment provided shall meet the requirements of these specifications. One copy of the approved data will be returned to the Contractor.

SD-05 Design Data

Design Calculations; G

Together with the shop drawings, Contractor shall submit complete set of detailed design calculations for the gates, hoists, frames, bonnets and bonnet covers including all accessories and appurtenances. The calculations should be in English and shall use feet, inches and pounds. The calculations shall be self-explanatory and shall include copies of all reference materials and data.

SD-08 Manufacturer's Instructions

Installation Instructions; G

The Contractor shall furnish detailed installation instructions, with sequence of installation, drawings, methods of handling and alignment procedures, installation tolerances, special tools and installation equipment needed.

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G

Operating and maintenance manuals shall be submitted for all equipment specified in this Section. The manuals shall include complete parts identification lists and detailed instructions for the operation, lubrication and maintenance of the equipment and for ordering replacements. The manual will be subject to approval by the Contracting Officer.

1.8 QUALITY ASSURANCE

The Contractor shall ensure that required tests, workmanship, and other performance aspects of the work comply with the applicable quality assurance requirements specified herein. In accordance with FAR 52.246-2, INSPECTION AND ACCEPTANCE, the Contractor shall provide continuous inspection of all operations for quality control and record the results for submitting to the Contracting Officer to show compliance with the Contract requirements.

1.9 DELIVERY, STORAGE AND HANDLING

1.9.1 Packaging

The equipment shall not be prepared for shipment until they have been inspected and accepted for shipment at origin by the Contracting Officer or his authorized representative, unless inspection has been waived in writing. Each component of equipment or subassembly shall be shipped completely assembled. The subassemblies shall be defined as the following:

1. Gate leafs.

2. Gate frames.

3. Sill beams.

4. Storage facilities.

5. Lifting of beams.

The subassemblies shall be provided with adequate protective pads, supports and blocking and shall be securely restrained to prevent distortion or damage to the painted surfaces in transit. Any loss or damage during shipment, including damage to the painted surfaces, will be considered the responsibility of the Contractor, and shall be replaced or repaired without cost to the Government. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY", or "SPARE PARTS ONLY". A packing list, listing the contents of each container, shall be placed in a moisture-proof envelope and securely fastened to the outside of the container. Standard commercial packaging in accordance with ASTM D 3951 will be acceptable except where a different method or standard of

packaging is specifically called for herein.

1.9.2 Shipping, Preservation and Storage

1.9.2.1 Shipping Responsibility

Packing, crating, cradles, etc., necessary to ensure safe shipment are the responsibility of the Contractor and shall become the property of the Government upon delivery of the equipment.

1.9.2.2 Protection of Machined Surfaces

Machined surfaces shall be adequately protected from corrosion and physical damage. Equipment delivered and placed in storage shall be stored with protection from the weather, humidity, temperature variation, dirt and dust, or other contaminants.

1.9.2.3 Small Parts

Small parts, such as bolts, anchor bolts, and other interchangeable parts which are packaged together for shipment, shall have the package labeled with the solicitation number, the part number, and the complete assembly identification.

1.9.2.4 Regulations and Provisions

Shipping shall be in accordance with applicable regulations and the following provisions.

a. Preparation for Shipment

1. General. The manufacturer shall prepare, pack and load all materials and equipment for shipment in such a manner that they are protected from damage during shipment and shall be responsible for and make good any and all damage resulting from improper packing. Items subject to open storage for several months at the site shall be suitably protected from weather damage. Where necessary, heavy parts shall be mounted on skids or shall be crated and any articles or materials that might be otherwise lost shall be boxed or steel banded in bundles and plainly marked for identification. All parts exceeding 200 pounds gross weight shall be prepared for shipment so that slings for handling by crane may be readily made. All parts subject to damage from moisture shall be packed in hermetically sealed metal containers or plastic envelopes with sufficient quantities of a hygroscopic material inside or in other approved containers,within their respective packing cases, with all machined surfaces heavily coated with a rust preventing compound. Each case, crate, bundle and single items shall be marked clearly with the name of the installation for which it is intended. Each container shall be clearly marked and the contents identified for proper warehousing. All fasteners and miscellaneous plates, templates, and fixtures required for field connections, splices, alignment, etc. shall be shipped in marked boxes keyed to the erection drawings. A complete packing list shall accompany each shipment.

2. Spare Parts. All spare parts shall be packed separately in containers plainly marked "Spare Parts Only" and indicating the items of equipment to which they belong. A packing list, indicating the contents of the Spare Parts. All spare parts shall be packed

separately in containers plainly marked "Spare Parts Only" and indicating the items of equipment to which they belong. A packing list, indicating the contents of the container, shall be securely fastened in a moistureproof envelope to the outside of each container. The packing list shall also provide the following information: container, shall be securely fastened in a moistureproof envelope to the outside of each container. The packing list shall also provide the following information:

(a) Manufacturer.

(b) Contract Number.

(c) Identification, including manufacturer's drawing number, of each spare part in container.

b. Release for Shipment. No equipment shall be shipped to the site until a written release for shipment is received by Contracting Officer.

c. Statement of Conformance. The manufacturer shall prepare a Statement of Conformance to accompany each equipment or material shipment sent to the Site, in order to provide certification by the manufacturer that the equipment and required documentation meet all requirements of these Contract Documents. The manufacturer's representative officially responsible for assuring that all requirements of these Contract Documents are met shall sign the Statement of Conformance.

d. Shipment. The manufacturer shall be responsible for obtaining shipping space, for insurance for the full value of the equipment until delivery at the delivery point, for freight, for securing and forwarding the shipping documents, and for the payment for all duties and shipping charges. It shall be the manufacturer's responsibility to establish the maximum shipping limitations for delivery to the delivery port.

1.10 PROJECT/SITE CONDITIONS

The Contractor shall visit the site to thoroughly familiarize himself with all details of the work, access, working conditions and constraints to verify dimensions in the field and he shall then advise the Contracting Officer of any discrepancies prior to performing any work. The Contractor shall be specifically responsible for the coordination and proper relation of his work to the structure and work of all trades.

1.10.1 WARRANTY

All equipment shall be guaranteed for a period of 5 years from the date of acceptance. Replacement parts shall be guaranteed for 5 years from date of replacement. Warranty shall be against defective materials, design, and workmanship. In cases where the equipment manufacturer's advertised minimum guarantee is in excess of 5 years, it shall remain in force for its full period. Upon receipt of notice from the Contracting Officer of failure of any of the parts during the warranty period, new replacement parts shall be furnished and installed promptly at no additional cost to the Contracting Officer. Any operational problems shall be rectified to the satisfaction of the Contracting Officer at Contractor's expense.

PART 2 PRODUCTS

2.1 MAINTENANCE BULKHEAD

2.1.1 General

Materials and mechanical equipment shall conform to the requirements indicated on the drawings or referred to herein, and when not covered thereby, materials and mechanical equipment of the best commercial grade quality suited to the intended use and as approved by the Contracting Officer shall be furnished. The manufacturer's name, address, and catalog number shall be permanently displayed on a nameplate securely attached to each major item of equipment.

Where items are referred to hereinafter as "similar and equal to" a particular manufacturer's product, such references have been made merely as a convenient method of indicating the type of material or equipment required, with no intention of asserting superiority thereof. The standard product of any reputable manufacturer regularly engaged in the commercial production of the type and quality of material or equipment referred to will not be excluded on the basis of minor differences, provided essential requirements of the specifications relative to materials, capacity, and performance are met. The Contractor shall, in accordance with Paragraph: SUBMITTALS, furnish for approval, performance capacities and other pertinent information concerning the manufacturer's "equal to" standard products which he intends to incorporate in the work. "Equal to" standard products installed or used without such approval shall be at the risk of subsequent rejection.

2.1.2 Bulkhead Gate

Each gate shall be rectangular in shape. The nominal height of 4.0 feet and the nominal width of 4.0 feet represent the dimensions of the waterway immediately downstream of the gate. The gate shall be fabricated of structural steel in single unit. The unit shall be of welded construction. The skinplates or load- bearing plates, and the gate seals shall be on the downstream and bottom sides of the gate. The bottom of the gate must be shaped so as to avoid vibrations and minimize hydrodynamic downpull or uplift forces, in order to ensure smooth closure operation under maximum operational head. The bottom seating surface of the gate shall be normal to the longitudinal gate axis, will be parallel to the gate sill as installed, and finished for uniform bearing thereon.

Guide springs may be provided, if so needed, on the gate to prevent the movement or shifting of the gate by wave action or minor flow disturbances. The guide springs shall bear against a metal guide to maintain a moderate bearing pressure between the seats and track. The springs shall be adjustable to obtain nearly uniform bearing between the wheels and track.

Gate seals shall be of natural or synthetic rubber or neoprene with side and top seals molded into music note shapes substantially as shown on the specification drawings. Seals shall be furnished in one piece drilled and ready for installation or shall be furnished in not over eight pieces with necessary drills, cement and vulcanizing equipment for field fitting. The tensile strength of all splices shall be not less than 50 percent of the tensile strength of the unspliced material. Seals shall be so mounted that the centerlines of seal contact faces on a centered and closed gate shall coincide with the centerlines of the seal seat faces. Specially molded corner seals shall be provided for use at seal corners. Side and top seals shall be designed and assembled to tightly contact their seats normally. Side and top seals shall have sufficient strength and flexibility to project 1/4 inch beyond normal and to resist failure and extrusion, should

unbalanced pressure be applied before they are opposite their seats and to return to normal setting when the pressure is equalized. All seals shall be mounted on machined plane surfaces. They shall be secured in place by bars and fastenings of corrosion-resistant metal. Fastenings may not be in the zones of seal and seat contact.

Each completely assembled bulkhead shall close readily by gravity with at least 33 percent excess of effective weight over frictional resistances under any conditions of reservoir water level, gate opening, and leakage flow conditions, and shall be watertight between lines of seals.

2.1.3 Gate Frames and Guides

Gate frames provided by the Contractor at the bulkhead intake shall each consist of a gate sill, wheel tracks mounted on bases and seal seats mounted on frames, and all fastenings, anchor bolts, and accessories required by the design. Gate frames and bases, including sills shall be installed in recesses in the primary concrete. Anchor bolts, placed with this concrete, shall be used for subsequent securing and alignment of the parts prior to embedment in secondary concrete. Except as noted, parts may be structural or cast steel. Seal seats and sill shall be fabricated from corrosion-resistant stainless steel plates, and may be furnished as rolled if within the specified dimensional tolerances unless specially noted and except that abutting edges shall be ground to provide continuity without offsets. Tracks and all fastenings that shall not be completely embedded also shall be fabricated from materials having corrosion- resisting properties. Tracks shall have the strength and hardness required to prevent permanent deformation under maximum load, shall be finished for closely fitted seating in machined recesses in the bases and shall be provided with adequate fastenings. Contact surfaces may be slightly crowned to prevent edge loading, and shall be tapered at their upper ends to properly engage the bulkhead. Each track, with the supporting base, may be fabricated in two lengths with milled close-fitting ends above the waterway section that provides an overlap of track on base of not less than 10 inches. Each track base shall be rigid enough to properly distribute loads to the concrete of the structure under hydraulic unbalance. All embedded members shall be designed to facilitate field connection and alignment, and the filling of the formed recesses with secondary concrete. Holes shall be required in embedded frame members for reinforcing steel. Sills as installed shall be normal to the longitudinal gate axes and shall be firmly attached to the side frame members. Reinforcement bars shall be provided in the second stage concrete to withstand maximum diagonal shear stress in the concrete due to maximum loads.

Rolled steel gate guides extending upward from the sill plates to the maintenance deck shall be attached to the track with adequate welding to withstand all possible gate forces. Guides shall be furnished in convenient spliced lengths, and shall be of such a shape that shall not be seriously affected by corrosion and can be readily handled without distortion and that, when installed, can adequately withstand any probable combination of gate and wave forces. Faces of guides shall be smooth and free of offsets, and if necessary, shall be finished to meet this requirement.

2.1.3.1 Lifting Beam

Lifting beam shall have two hooks to engage the bulkhead at its center. The lifting beam shall be semi-automatic type of proven design. A counterweight actuated mechanism with manual lever can be used for such automatic operation. During lowering operation, the lifting beam shall

automatically release the gate only after the gate rests fully on the sill under water. During raising operation, the lifting beam shall automatically grapple the closed bulkhead under water. The lifting beam shall utilize the same gate frames and guides as provided for the maintenance bulkhead. All pins and axles for the hooks and guide rollers shall be of stainless steel with self lubricating bronze bushings. All fasteners used in assembling the lifting beam shall be of stainless steel. Bronze shoes are permitted on the guides as needed.

The wire ropes shall be of Type 316 stainless steel with a safety factor of 8 based on breaking strength of rope.

Suitable lubrication provision shall be made for all hook pins and guide roller axles.

2.2 Special Tools to be Furnished

The Contractor shall furnish all special tools required for disassembly and maintenance of the equipment. In addition, a slugging wrench shall be furnished for the gate leaf nuts and spanner wrenches as needed. A complete list of special tools shall be furnished by Contractor.

2.3 Spare Parts

A set of spare parts as recommended by the manufacturer shall be supplied. All spare parts shall be duplicates of the original parts they are interned to replace. Each spare part shall bear a tag or label securely attached clearly identifying the component for which it is intended. Spare parts shall include but not be limited to:

1. One spare set of all rubber or neoprene seals and packings.

2. One spare set of bushings proposed to be used.

3. One spare set of Type 316 stainless steel wire ropes.

4. Ten percent of all bolts and fasteners.

5. One spare set of storage chains and accessories.

PART 3 EXECUTION

3.1 Shop Assembly and Tests

3.1.1 General

3.1.1.1 Shop Assembly

The bulkhead along with lifting beam and seals shall be completely shop assembled. All shop assemblies and tests specified below for the various items of equipment will be witnessed by a representative of the Contracting Officer unless specifically waived in writing. Copies of all shop inspection records shall be furnished. No equipment shall be shipped from manufacturer's shops until it has been inspected or inspection has been waived in writing by the Contracting Officer on an item-by-item basis. Prior to major shop assemblies and tests, the manufacturer shall submit for review an outline of the procedures and tests he plans to perform to demonstrate fulfillment of the requirements of the Specifications. The shop tests shall be based on the reviewed and approved procedures.

3.1.1.2 Shop Inspection

While being assembled, each item of equipment shall be checked for dimensions, tolerances, accuracy of alignment workmanship and compliance to approved drawings. Any deficiencies and deviations from the contract and/or approved drawings shall be corrected. All instruments and devices required during the inspection for the examination, measurement or testing of the equipment shall be provided and calibrated by the manufacturer.

3.1.1.3 Matchmarking

Before disassembling and after installation of dowels and fitted bolts between bolted subassemblies, all parts shall be clearly matchmarked. Matchmark diagrams for field erection use shall be prepared and submitted to the Engineer.

3.1.1.4 Cost of Inspection

The direct cost of all inspection trips by the Contracting Officer's representatives shall be borne by the Contractor. A minimum of two 5-day inspection trips shall be assumed. The cost (round-trip air fare, per diem, lodging and car rental cost) shall assume Los Angeles as the departure point and the various locations of gate equipment manufacturing as the destination. Air travel shall be business-class travel with no restrictions and shall be by the most direct route possible. The estimated per diem shall be based at a minimum, upon information from the Federal Register Chapter 301, Travel Allowances, Appendix A, or similar guidelines for selected destinations. The cost of additional trips or longer duration trips resulting from poor scheduling, lack of preparedness, unforeseen conditions or non-conformance to contract requirements shall be at no additional cost to the Government. All travel arrangements shall be made by the Contractor in coordination with the Contracting Officer with all costs paid directly by the Contractor.

3.1.2 Embedded Parts

3.1.2.1 Shop Assembly

Each embedded frame, including sill beam, seal plates, track plates, bearing plates, and side members, shall be completely shop assembled and checked for correct fit and alignment. This may be done in either the vertical or horizontal position.

3.1.2.2 Field Assembly

Other members of embedded parts shall be shop assembled in partial lengths successively joining their matching connections so that each field connection will be checked for assembly at least once.

3.1.3 Bulkhead Gate

3.1.3.1 Shop Assembly

The finished and painted bulkhead including seals, guiding devices and all other applicable accessories shall be completely shop assembled. All field splices shall be assembled; welded field-splices shall be temporarily bolted for shop assembly.

3.1.3.2 Fitting of Seals

All seals shall be fitted to their supports during the shop assembly and proper allowances shall be made for shrinkage after aging.

3.1.3.3 Field Quality Control

The assembled bulkhead shall be lifted vertically and checked for plumbness within specified tolerances. The location of the ballast to attain required plumbness and the total weight of the gate shall be noted on the shop drawings.

3.1.4 Miscellaneous Items

All other items not specifically covered above and whose testing is critical prior to shipment shall be shop tested.

3.2 INSPECTION AND TESTING OF PAINT

3.2.1 General

Paint inspection and testing shall be done as discussed in the following paragraphs.

3.2.1.1 Before and During Painting

a. Temperature and humidity during application and curing as set forth in approved application procedures.

b. Surface cleanliness and anchor profile by visual methods as set forth in approved application procedures.

c. Curing times and conditions for curing as set forth in approved application procedures.

3.2.1.2 After Painting

a. Required film thickness as set forth in approved application procedures.

b. Holiday testing by wet sponge method. Coating shall be 100 percent holiday free.

c. Non-destructive adhesion testing per ASTM D 4541. Acceptance criteria shall be as recommended by paint supplier.

3.3 TEST DATA

During the shop tests, all data needed for proper evaluation of the performance of the equipment shall be recorded. All test data shall be submitted for approval. If the test data do not demonstrate compliance with the specified requirements, all required remedial actions shall be performed and the necessary tests shall be repeated until complete compliance is demonstrated.

3.4 MARKING

All parts of each bulkhead assembly shall be marked and match-marked for identification to facilitate field erection and, in addition, all parts of

each assembly shall be marked for ready identification with the proper assembly and to show the relative position of the part in the assembly. A diagram of such marking shall be submitted for approval. All joints shall be shop fitted and match-marked before shipping.

3.5 FIELD TESTING

After installation of the bulkhead, with all lifting beam accessories, a test for watertightness of the system shall be made using water jets under pressure with soap bubble solution. Operating in each intake at a time, the bulkhead shall be raised to the full open position up to storage position. The gate shall then be lowered to the closed position. After the completion of this test and bulkhead gate shall be operated through four cycles in both openings. The leaf shall travel smoothly with no tendency to chatter through the entire range of the leaf travel. Any defects and problems shall be rectified by the manufacturer to the complete satisfaction of USACOE at Contractor's expense.

3.6 PAINTING

The gates, frames and lifting beams including storage facilities and accessories shall be dismantled as required and cleaned as specified on the drawings and in SECTION 09940: PAINTING HYDRAULIC STRUCTURES AND APPURTENANT WORKS before painting as follows: The non-embedded ferrous surfaces of the frames, storage facilities and air vents and the entire area of all gate leaves and lifting beams shall be painted according to paint system 4. Seals shall not be painted. The embedded surfaces of the frames shall not be painted. Stainless steel surfaces shall not be painted.

All unpainted finished surfaces exposed to the atmosphere during shipment shall be coated with a corrosive preventive compound.

3.7 STORAGE

If the bulkhead is assembled when shipped, the Contractor may store the assembled gates indoors or outdoors. The gates shall rest on timbers so that no part of the assembly is in contact with the ground. The frames, leaves, lifting beams and all accessories may be stored outdoors and shall rest on timber so that no part is in contact with the ground.

3.8 INSTALLATION

All equipment shall be erected in strict conformity with the match marks, taper pins and dowels used at the time of shop assembly. The parts shall be aligned with the taper pins and dowels and then bolted together. Two prints of the match marked drawings shall be shipped with the equipment. The frames and storage latches shall be held rigidly in place, true to grade, line and height, until placing of the concrete is completed. The frame and seals surfaces shall be set and maintained so that no part of the sealing surfaces shall deviate from a vertical plumb plane by more than 0.010 inch provided that the deviation shall not exceed more than 0.002 inch per foot. During installation, all bolts shall be tightened by calibrated torque wrenches. The torque reading of wrenches shall be approved. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to retighten bolts which may have been loosened by the tightening of subsequent bolts, until all bolts are tightened to the prescribed amount. The outside surfaces of the gate frames, and other parts to be embedded in concrete shall be cleaned of all rust, grease and dirt before the concrete is placed. After installation,

all gate frames, and similar parts shall be tested with a hammer to detect possible voids in adjacent concrete. Three-fourths-inch N.P.T. holes shall be drilled and tapped as needed if voids are detected. Voids shall be grouted and the grout holes shall be fitted with solid steel pipe plugs and ground smooth. Grouting pressures shall not exceed 50 psi. After all concreting and/or grouting operations have been completed, a survey shall be conducted to determine whether or not the above specified tolerances have been maintained. If the specified tolerances have not been maintained, such corrective action shall be taken as directed or approved by the Contracting Officer.

3.9 EQUIPMENT GUARANTEES

3.9.1 General

All guarantees and warranties, whether express or implied, of materials, equipment, or workmanship running in favor of the Contractor and manufacturer shall be transferred and assigned to the purchaser at the completion of installation and testing of any equipment furnished under this contract, and before final payment is made for such equipment. The Contractor and manufacturer shall obtain the consent of any relevant manufacturer or supplier of material, equipment or workmanship to the transfer and assignment of such warranties and guarantees to the Contracting Officer. Such guarantees and warranties shall be in addition to those required of the Contractor and manufacturer by other provisions of these Contract Documents.

The Contractor and manufacturer shall, at the date of final inspection and acceptance, issue guarantees for all permanent equipment furnished by the Contractor and manufacturer under these contract Documents that they shall be free of all defects in design, workmanship and materials; that they shall meet each and every criterion and condition of these Contract documents; and that they shall perform in accordance with any and all performance guarantees, as contained in the contract documents, or as given by the Contractor and manufacturer, which guarantees shall be effective for 5 years from the date of final inspection and acceptance.

3.9.2 Failure to Meet Guarantees

Should any of the equipment fail to meet the guarantees or other requirements of the Contract Documents within the time covered by the guarantees, the Contracting Officer shall direct the Contractor and manufacturer to proceed at once to make alterations or furnish new parts as may be necessary to meet the requirements. All expenses of furnishing, delivering, and installing new parts, or making alterations to existing parts, and of tests made necessary by failure of the equipment to meet the guarantees and other requirements for the Contract Document shall be borne by the Contractor and manufacturer. If, after due notice, the Contractor and manufacturer shall refuse to correct any failure of the equipment to meet the requirements of the Contract Documents during the guarantee period, the purchaser may proceed at its own expense to correct such failure and to collect from the contractor and manufacturer an amount equal to the actual expense so incurred, including overhead and all other incidental expenses. This remedy of the purchaser is in addition to any and all other remedies provided for in the Contract Documents, or as provided for by law or equity.

3.10 Services of Erection Engineer(s)

The bulkhead supplier shall be required to provide one or more competent erection engineer who shall supervise and be responsible for the correctness of the contractor's assembly procedures, method of alignment, installation of equipment and testing. When so requested, he shall also supervise and be responsible for initial starting and all subsequent operation of the equipment until the field tests are completed. The erection engineer shall instruct the Contracting Officer for a minimum of one full day, in the operation and maintenance features of the equipment. The erection engineer shall cooperate fully with the Contractor, however, the work and operation of the manufacturer's representative shall be directed by the Contracting Officer. The Contracting Officer shall be given 30 calendar days advance notice of the time when such services of the manufacturer's representative shall be needed and the Contractor shall be held responsible for any work done in the absence of the manufacturer's representative. Any errors in work done in the absence of the erection engineer, or work which does not conform to the instructions issued by the manufacturer, shall be corrected.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15097

REGULATING OUTLET SLIDE GATES

-- End of Section Table of Contents --

SECTION 15097

REGULATING OUTLET SLIDE GATES

PART 1 GENERAL

1.1 GENERAL INFORMATION

This section covers all work required for the 9-foot 9-inch by 14-foot 9-inch regulating outlet service gates, including gate frames (bodies), bonnets, bonnet covers and accessories. The hydraulic hoists and control systems are covered in SECTION 11290, HYDRAULIC POWER SYSTEMS FOR REGULATING OUTLET GATES.

1.2 MANUFACTURER PREQUALIFICATION

The regulating outlet service gates, frames, bonnet covers, bonnets, and all other associated elements shall be the product of a manufacturer regularly engaged in the design and fabrication of water flow regulating gates of similar size and rating. The manufacturer shall submit documentation demonstrating experience in successful design, fabrication, installation and operation of comparably sized gates.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent applicable. The publications are referred to in the text by basic design notices only. Latest versions and revisions shall be used regardless of dates shown.

1. AISC Manual for Steel Construction - Allowable Stress Design (1989).

2. USACOE Manual EM 1110-2-2105, Design of Hydraulic Steel Structures.

3. Design Guidelines for High Head Gates - ASCE Hydro Gates Task Committee (ASCE Journal of Hydraulics Division, December 1995).

4. Handbook of Applied Hydraulics, Davis and Sorensen, Third Edition (1984).

ACI INTERNATIONAL (ACI)

ACI 318	(1995) Building Code Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1997ael) Carbon Structural Steel
ASTM A 182	(1995) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High- Temperature Service

ASTM A 216	(1993) Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A 312	(1995) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 564	(1995) Hot-Rolled and Cold-Finished Age-Hardening Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A 536	(1999el) Ductile Iron Castings
ASTM A 789	(1995) Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
ASTM B 584	(1998a) Copper Alloy Sand Castings for General Applications
ASTM D 3951	(1995) Practice for Commercial Packaging

CORPS OF ENGINEERS (COE)

COE EM-1110-2-2105	Design of Hydraulic Steel Structures

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G

Shop drawings and catalog cuts for Contractor-designed details.

Where approval data are required for commercial products or equipment, the Contractor shall submit complete identifying data giving the manufacturer's name, type model, size, and characteristics of the equipment. When a catalog sheet is submitted, the particular item proposed shall be underlined or marked. The data shall be comprehensive and shall fully demonstrate that all equipment provided shall meet the requirements of these specifications. One copy of the approved data will be returned to the Contractor.

SD-05 Design Data

Design Calculations; G

Together with the shop drawings, Contractor shall submit for approval complete set of detailed design calculations for all components of the gates, hoists, frames, bonnets and bonnet covers including all accessories and appurtenances. The calculations

shall be in English and shall use feet, inches and pounds. The calculations shall be self-explanatory and shall include copies of all reference materials and data.

a. General. All drawings submitted by the Contractor shall have the Contractor's title and drawing number on each drawing. Drawings and data shall show the appropriate specifications section number. All dimensions shall be in feet and inches and all wording, signs, symbols, etc. shall be in English.

b. Approval Drawings and Data. Before proceeding with fabrication or procurement of material, the Contractor shall submit to the Contracting Officer for approval, complete sets of shop drawings, material specifications design calculations, and commercial products data. Drawings shall conform to the specification requirements. Any fabrication or procurement performed, or shipment made, prior to approval of the drawings and data, shall be at the Contractor's risk. The USACOE shall have the right to require the Contractor to make any changes in the equipment design which the USACOE determines necessary to make the equipment conform to the requirements of these specifications without additional cost to the USACOE. Approval by the USACOE or by the A/E of the Contractor's drawings or data shall not be held to relieve the Contractor of any part of the Contractor's responsibility to meet all of the requirements of these specifications or of the responsibility for the correctness of the Contractor's designs and drawings.

SD-08 Manufacturer's Instructions

Installation Instructions; G

The Contractor shall furnish detailed installation instructions, with sequence of installation, drawings, methods of handling and alignment procedures, installation tolerances, special tools and installation equipment needed.

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G

Operating and maintenance manuals shall be submitted for all equipment specified in this Section. The manuals shall include complete parts identification lists and detailed instructions for the operation, lubrication and maintenance of the equipment and for ordering replacements. The manual will be subject to approval by the Contracting Officer.

1.5 SPECIFICATION DRAWINGS

The specification drawings indicate the general arrangement, clearances (necessitated by structure and other equipment), maximum overall dimensions and other pertinent features. The Contractor shall be entirely responsible for all design and shall prepare designs and shop drawings in conformity with the specifications and design criteria included in the solicitation. The Contractor shall submit design calculations, shop drawings and catalog data for approval prior to manufacture. The details, welds and other sizes or dimensions of structural members are intended as minimum requirements

and shall be adopted by Contractor at his discretion. The Government accepts no responsibility for their design adequacy or correctness of the dimensions.

1.6 DESIGN AND PERFORMANCE REQUIREMENTS

1.6.1 General

The Contractor shall design in conformity with these specifications, references listed in paragraph: REFERENCES as applicable, and the following design criteria.

1.6.2 Design Parameters

1.	Gate Sill Elevation	470.0
2.	Hydrostatic Design Head	126 Feet Measured from Gate Centerline (Pool Elevation 596.0)
3.	Operational Head	96 Feet Measured from Gate Centerline (Pool El. 566.0)
4.	Nominal Gate Width	9 Feet 9 Inches
5.	Nominal Gate Height	14 Feet 9 Inches
6.	Type of Gate	Highhead Slide Type
7.	Type of Hoist	Oil Operated Hydraulic Cylinder

b. Each gate shall be designed to be suitable for satisfactory and reliable throttling service for prolonged periods in any position between fully closed and fully open positions without vibrations, cavitation, oscillations or seizing or galling problems.

c. Downpull. Downpull on the gate shall be calculated based upon Hydraulic Design Criteria, Sheets 310-2 through 320-2/3 (Revised 10/61) of the U.S. Army Corps of Engineers on the following pages or other acceptable methods based upon hydraulic model studies on similar installation.

d. Gate Deflection. The maximum allowable deflection of the gate shall be less than 1/2,500 of the span.

e. Earthquake Forces. Forces due to earthquakes shall be determined in accordance with SECTION 13080 of these specifications.

1.6.3 Allowable Stresses

The allowable stresses shall be as specified by COE EM-1110-2-2105, U.S. Army Corps of Engineers Manual for Design of Hydraulic Steel Structures. Where stress conditions and materials are not covered in COE EM-1110-2-2105, the following shall govern:

1. For rolled, forged or stainless steel, the tensile and compression

stresses shall not exceed 40 percent of yield point or 25 percent of ultimate strength or 16,200 psi, whichever is lower.

2. For rolled or forged steel bolts, the maximum tensile or compression stresses shall be limited to 25 percent of yield point or 16.5 percent of ultimate strength, whichever is lower.

3. For cast steel, the maximum tensile and compression stresses shall be limited to 33 percent of yield point or 20 percent of ultimate strength, whichever is lower.

4. For cast iron, the maximum tensile strength shall not be greater than 16.5 percent of ultimate strength.

5. For brass or bronze, the maximum tensile and compressive stress shall not exceed 33 percent of yield point or 16.5 percent of ultimate strength, whichever is lower.

6. For shear, the maximum stress shall be less than 0.6 times the allowable tensile stress, except for cast iron, the permissible shear stress shall be equal to the allowable tensile stress.

7. Bearing stress between leaf and bronze seats shall not exceed 1,500 pounds per square inch.

8. For design purposes, the coefficient of friction between the leaf and bronze seal seat shall be assumed as 0.60.

9. A corrosion allowance of 1/16 inch for structural steel members subject to submergence shall be made.

10. Parts of the equipment embedded in concrete structures and parts bearing on concrete shall be designed in accordance with the requirements of ACI 318 and based upon a 28-day concrete compres sive strength of 4,000 psi.

1.6.4 Loading Conditions

The equipment shall be designed to withstand stresses during static as well as operational conditions corresponding to the loading conditions as stated below:

Normal Load Condition: For reservoir elevation of 596.0

Overload Condition: For reservoir elevation of 596.0 plus the forces as determined for earthquake forces.

For materials and stresses not covered by USCOE Engineering Manual COE EM-1110-2-2105, the allowable stresses for normal loading condition shall be the normal design stresses defined above. The allowable stresses for the overload condition shall not exceed the normal design stresses by more than 33-1/3 percent or 0.75 of the yield stresses of the materials, whichever is lower.

1.6.5 Materials

The following materials and latest versions of the material specifications shall be used. If the bidder intends to substitute any of the materials, he should clearly state so in his bid and the reasons for substitution. He

shall submit the specifications for such alternative materials.

1. Gate leaf, frames, and bonnets shall be of structural steel conforming to ASTM A 36.

2. Gate seal seats shall be of aluminum bronze with copper 85-86.5 percent, aluminum 9.5-10.5 percent, and iron 3-4 percent.

3. Stem socket shall be of cast steel conforming to ASTM A 216, Grade WCC.

4. Stem nut shall be of manganese bronze conforming to ASTM B 584, Alloy No. 862.

5. O-ring retainer shall be of cast bronze conforming to ASTM B 584, Alloy No. 93.

6. Piston stem shall be of stainless steel with ceramic coating conforming to ASTM A 564, Type 630.

7. Gate stem shall be of stainless steel conforming to ASTM A 564, Type 630.

8. Piston shall be of cast iron conforming to ASTM A 536, Grade 80-55-06.

9. Hydraulic cylinder shall be of cast steel conforming to ASTM A 216, Grade WCC steel.

10. Cylinder flanges shall be of cast steel conforming to ASTM A 216, Grade WCC steel.

11. Oil piping (1-inch diameter and larger) shall be of seamless stainless steel conforming to ASTM A 312, Grade TP 304, Schedule 80 S.

12. Pipe fittings shall be of stainless steel conforming to ASTM A 182, Grade F 304, three thousand pounds pressure class.

13. Tubing (less than 1 inch diameter) shall be of stainless steel conforming to ASTM A 789.

14. Lubricating fittings shall be alemite, Type A-1188 or A-1184, as manufactured by Alemite Division of Stewart Warner Corp., 1826 West Diversey Parkway, Chicago, IL 60614, or equal.

15. Grout for machinery shall be non-shrink epoxy grout.

16. Fluoro-carbon (PTFE) bushings and washers shall be "Rulon A" as manufactured by the Dixon Industries Corporation, Bristol, Rhode Island 02809, or equal.

17. High strength fiber-reinforced phenolic bearing material shall be "ORKOT TLM" as manufactured by ORKOT Engineering Plastics, 2535 Prairie Road, Unit D, Eugene, Oregon 97402, or equal.

18. Neoprene seals shall be molded of neoprene compound or copolymer of butadiene and styrene or a blend of both. The compound shall contain not less than 70 percent by volume of the basic polymer, and the remainder shall consist of reinforcing carbon black, zinc oxide,

accelerators, antioxidants, vulcanizing agents, and plasticizers.

19. Fluoro-carbon clad rubber seals shall be as specified above. A fluoro-carbon sheath shall be bonded to the rubber on the sealing surface. The sheath shall abrasion resistant Fluoro-Carbon Film No. 4508 as manufactured by Buck-horn, Inc., 55 West Technecenter Drive, Milford, OH 45150, or equal. The outside surface of the fluoro-carbon sheath shall be free of adhering or bonded rubber.

20. Elastomeric sealing rings (O-rings) shall be vulcanized compound of Nitrile Butadiene Rubber, Urometer A hardness 55±5 and tensile strength 2,500 psi minimum.

21. Lubricating oil shall be ISO VG 46, Mobil D.T.E. oil medium or Shell Turbo Oil T46 or equal.

22. Hydraulic fluid shall be Mobil EAL224H or equal.

1.6.6 Anchors and Alignment Provisions

The Contractor shall be responsible to design and provide adequate number of anchors welded to the gate frames and bonnets. These frames and bonnets, together with anchors, should be designed for external water load equal to the maximum pool pressure. External tension anchors shall transfer the water load to the concrete by compression and/or bearing and shall prevent the gate frames and bonnets from collapsing inward if leakage occurs around the conduit liner and bonnets. The allowable tensile and bending stresses in the structural steel members and anchors shall not exceed 16,200 pounds per square inch. The anchors shall be preferably U-shaped steel straps 1-1/2 inches wide and about 18 inches in embedded depth.

The Contractor shall be responsible to provide adequate alignment anchors with turnbuckles to permit precise alignment of the gate frames and bonnets. Provisions such as seats welded to frames for hydraulic jacks and other erection tackle shall be made.

1.6.7 Surface Roughness and Finish

The Contractor shall indicate on his submittal drawings the surface roughness specified by numbers in check-type marks on the surfaces, which shall be machine finished and shall conform to the surface quality specified in ANSI B46.1, entitled, "Surface Texture", published by ANSI.

1.6.8 Welding and Stress Relieving

All welding used in fabricating the cylinders, and all radiographing and stress relieving specified shall be in accordance with the "ASME Boiler and Pressure Vessel Code, Section VIII, Division 1", referred to hereafter as the ASME Code. Welding of structural steel shall be performed in accordance with the Structural Welding Code of AWS, wherein the words "Building Commissioner" shall be interpreted to mean contracting officer. Where there is a conflict between the codes and this solicitation, the latter shall govern. If materials other than the foregoing are to be welded, procedures shall follow the best modern practice.

Shielded or submerged arc welding methods shall be used, and whenever practicable, welding shall be done with automatic machines. Weld sizes and types shall conform to those specified on the drawings. Unless

specifically stated otherwise, welded parts requiring machine finish shall be completely welded and stress relieved before being finished.

All welding shall be done by code qualified welders. If, in the opinion of the contracting officer, the work of any welder appears questionable, the welder shall be required to pass an appropriate qualification test.

The cylinder, bonnet cover, bonnet and bodies shall be stress relieved by heating the entire part as a unit in a furnace in accordance with the ASME Code. The gate leaf shall be stress relieved by any commercial vibratory method equivalent to the "Formula 62" process of the Stress Relief Engineering Company of Costa Mesa, California, which results in a dimensionally stable product. Stress relieving shall be done before performing any required machine finish work.

All joints in the shell of the cylinder which will be subjected to internal pressure shall be radiographed throughout their entire length in accordance with the ASME Code. Other welds which the contracting officer deems questionable shall be checked by dye penetrant or other suitable methods to insure weld soundness. Any defective welds shall be repaired, using procedures which are acceptable to the Contracting Officer.

1.7 QUALITY ASSURANCE

The Contractor shall ensure that required tests, workmanship, and other performance aspects of the work comply with the applicable quality assurance requirements specified herein. In accordance with FAR 52.246-2, INSPECTION AND ACCEPTANCE, the Contractor shall provide continuous inspection of all operations for quality control and record the results for submitting to the Contracting Officer to show compliance with the Contract requirements.

1.8 DELIVERY, STORAGE AND HANDLING

1.8.1 Packaging

The equipment shall not be prepared for shipment until they have been inspected and accepted for shipment at origin by the Contracting Officer or his authorized representative, unless inspection has been waived in writing. Each component of equipment or subassembly shall be shipped completely assembled. The subassemblies shall be defined as the following:

a. Gate leafs.

b. Upstream gate frames.

c. Downstream gate frames.

d. Bonnets.

e. Bonnet covers.

The subassemblies shall be provided with adequate protective pads, supports and blocking and shall be securely restrained to prevent distortion or damage to the painted surfaces in transit. Any loss or damage during shipment, including damage to the painted surfaces, will be considered the responsibility of the Contractor, and shall be replaced or repaired without cost to the Government. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY", or "SPARE PARTS

ONLY". A packing list, listing the contents of each container, shall be placed in a moisture-proof envelope and securely fastened to the outside of the container. Standard commercial packaging in accordance with ASTM D 3951 will be acceptable except where a different method or standard of packaging is specifically called for herein.

1.8.2 Shipping, Preservation and Storage

Packing, crating, cradles, etc., necessary to ensure safe shipment are the responsibility of the Contractor and shall become the property of the Government upon delivery of the equipment.

Machined surfaces shall be adequately protected from corrosion and physical damage. Equipment delivered and placed in storage shall be stored with protection from the weather, humidity, temperature variation, dirt and dust, or other contaminants.

Small parts, such as bolts, anchor bolts, and other interchangeable parts which are packaged together for shipment, shall have the package labeled with the solicitation number, the part number, and the complete assembly identification.

a. Shipping shall be in accordance with the following provisions.

1. Gates and Hoists. Each outlet gate shall be disassembled in the shop so each of the following principal subassemblies can be shipped as units. Hoist and bonnet cover assembly, including the piston and piston stem, leaf with lower seals assembled, upstream and downstream bonnets with guides assembled, and upstream and downstream bodies with seats and guides assembled, if applicable. The indicator stem shall be removed and shipped separately. The piston shall be blocked against the cylinder head, and the cylinder shall be filled with hydraulic oil, both above and below the piston. About 1 quart of hydraulic oil shall then be drained from under the piston and about 1 cup from above the piston. The extending portion of the piston stem shall be wrapped with heavy protective paper or burlap and covered with wooden strips wired or banded around the circumference. The leaf shall be securely crated or boxed so that all finished surfaces are completely covered with wood. Exposed finished flange surfaces of the bodies and bonnets shall be covered with a rust-preventive compound and protected with firmly secured wooden covers. The indicator stem shall be crated carefully to prevent damage during shipment. Special care shall be used in blocking parts or shipping units to prevent damage to the metal or paint from vibration, rubbing or shifting in transit.

Three signs spaced equally around the circumference of the piston stem shall be painted on the wooden strips stating ‘DO NOT USE FOR LIFTING". A conspicuous arrow shall be painted on the cylinder of the gate hoist assembly pointing to the bonnet cover with the note "STORE WITH THIS END DOWN".

2. Liners and Bonnets. Before disassembling and with the bonnets, liners, and body joints aligned, the flanges shall be reamed for taper pins and shall be suitably match marked. Any offsets existing at the fluidway joints shall be ground flush and joined in accordance with this solicitation and drawings.

1.9 PROJECT CONDITIONS

The Contractor shall visit the site to thoroughly familiarize himself with all details of the work, access, working conditions and constraints to verify dimensions in the field and he shall then advise the Contracting Officer of any discrepancies prior to performing any work. The Contractor shall be specifically responsible for the coordination and proper relation of his work to the structure and work of all trades.

1.10 WARRANTY

All equipment shall be guaranteed for a period of 5 years from the date of acceptance. Replacement parts shall be guaranteed for 5 years from date of replacement. Warranty shall be against defective materials, design, and workmanship. In cases where the equipment manufacturer's advertised minimum guarantee is in excess of 5 years, it shall remain in force for its full period. Upon receipt of notice from the Contracting Officer of failure of any of the parts during the warranty period, new replacement parts shall be furnished and installed promptly at no additional cost to the Government.

PART 2 PRODUCTS

2.1 REGULATING OUTLET GATES

2.1.1 General

Materials and mechanical equipment shall conform to the requirements indicated on the drawings or referred to herein, and when not covered thereby, materials and mechanical equipment of the best commercial grade quality suited to the intended use and as approved by the Contracting Officer shall be furnished. The manufacturer's name, address, and catalog number shall be permanently displayed on a nameplate securely attached to each major item of equipment.

Where items are referred to hereinafter as "similar and equal to" a particular manufacturer's product, such references have been made merely as a convenient method of indicating the type of material or equipment required, with no intention of asserting superiority thereof. The standard product of any reputable manufacturer regularly engaged in the commercial production of the type and quality of material or equipment referred to will not be excluded on the basis of minor differences, provided essential requirements of the specifications relative to materials, capacity, and performance are met. The Contractor shall, in accordance with Paragraph: SUBMITTALS, furnish for approval, performance capacities and other pertinent information concerning the manufacturer's "equal to" standard products which he intends to incorporate in the work. "Equal to" standard products installed or used without such approval shall be at the risk of subsequent rejection.

2.1.2 Gate Frames

Each gate frame shall include upstream body or liner and downstream body or liner, which shall be of welded steel construction. Frames backing the side seats for the slide gates shall be designed to transmit the loads safely to the concrete. The gate frames shall be designed for external water load equal to the maximum pool pressure with conduit empty. External tension anchors shall be welded to the gate frame ribs to transfer the water load safely by compression and/or bearing and shall prevent the gate frames from collapsing inwards if leakage occurs around the conduit liners and bonnets.

Mating edges of joined fluidway sections shall match within one-eighth inch and shall be ground flush with an approach slope of no steeper than 1:40. The fluidway surfaces shall be free from abrupt irregularities.

All corner fillet welds in the fluidway shall be ground to a radius of 3/8-inch.

The surfaces of the fluidway shall be smooth with no pronounced offsets, waves or distortions. The flatness of the surfaces shall be such that no more than a 3/32-inch feeler can be inserted between the surface and a 3-foot straight edge held in any position.

The surfaces of welded parts shall be in alignment and all welds shall be ground flush. All weld spatter shall be removed from the fluidway.

Corner welds of gate frames shall be ground to a radius of 5/16-inch into a concave shape.

Gasket materials, bolts, and nuts shall be furnished for all flanged connections. The gate frame shall be provided with seal seats of a bearing bronze capable of withstanding a slow sliding friction with the stainless steel cladding of the gate leaves with a bearing pressure of 1,000 pounds per square inch without seizing or galling and with a maximum friction factor of 0.6. Suitable grease piping with fittings shall be provided to permit lubrication of sliding surfaces with the grease fittings being located near the bonnet covers. Suitable grease grooves shall be provided in the seal seats to distribute the grease around the full contact areas. The inner or fluidway edge of each seat shall be finished to the contour shown on the drawing. The faces of the seal seats on the downstream frame shall be smooth finished to lie in a common plane parallel with the gate centerline. When the gate leaf and frames are assembled with the leaf closed and held firmly against the seal seats, there shall be no space between the contacting gate and frame seal-seating surfaces into which 0.006-inch feeler gage can be inserted. The bottom seat shall be strong and rigid enough to sustain the full gate weight plus maximum hydraulic hoist thrust pressure.

2.1.3 Gate Leafs

Each gate shall be of welded-steel construction. The gate leaves shall have Type 316 stainless (18-8) steel clad downstream faces substantially as shown on the specification drawings. The cladding shall not be less than one-eighth inch thick after machining and shall continue across the bottom seat to an extent and with an approximate contour as shown on the drawings. The clad downstream face shall be flat so as to maintain contact with the seal seats at all gate openings. Alternatively, solid stainless steel skinplates are acceptable. The seal seats shall lie in a plane surface. Lifting lugs shall be provided at the top of the gate leaf to facilitate installation and disassembly.

2.1.4 Bonnets

The gate bonnets shall be of welded steel construction. The top 12 inches of the gate bonnet shall be designed for 54-pounds-per-square-inch-fluidway pressure and shall be bolted to a bonnet cover designed for the same pressure, combined with a maximum thrust in either direction resulting from maximum cylinder pressure. Bonnet and bonnet cover shall be capable of transmitting such hoist loads to the concrete. The bonnets and frames must

be strong enough to prevent distortion during transportation and to withstand, without distortion, an external pressure of at least 10 pounds per square inch during concrete embedment.

The bonnets must also be designed for external water load equal to the maximum pool pressure with the conduit empty. Adequate number of anchors shall be welded to the bonnet ribs to transfer the external water load to concrete safely.

2.1.5 Bonnet Covers

The bonnet cover shall be designed to withstand an upward pressure of water of 54 psi, in addition to the hoist loads and forces during operation of the gates resulting from maximum cylinder pressure in either direction of gate operation. Bonnet and bonnet cover shall be capable of transmitting such loads to the concrete embedment. The bonnet cover shall be bolted to the bonnet using high strength high torque bolts. Suitable V or Chevron packings shall be provided at the openings for gate stem through the bottom cylinder head and the bonnet cover. The bottom cylinder head and the bonnet cover must provide accurate axial alignment of gate and hoist when gate is contacting its seal seats.

2.1.6 Seats

The seat bars fastened to gate frames shall be machined to a snug fit with their bearing seats to provide a solid backing. Slide gate leaf seats shall be aluminum bronze conforming to a chemical analysis of copper, 85-86.5 percent; aluminum 9.5- 10.5 percent; and iron of 3.0-4.0 percent. The seats shall be forged or hammered to a Brinell hardness of 180 to 200. This material has a chemical analysis similar to the commercial product "AMPCO 16 and 18" as produced by Ampco Metal Division of Ampco-Pittsburgh Corporation, Milwaukee, Wisconsin 53201, phone: (414) 645-3750. If babbitt seat recess is used, it shall be tinned before the babbitt is poured. The babbitt shall be thoroughly peened after pouring and then machined to the finish as shown on the shop drawings approved by the Contracting Officer. Alternatively, stainless steel seats for gate bottom seal is acceptable. The welds connecting the seal bars to the gate leaf and the corrosion resistant weld on the gate leaf lip shall be made after stress-relieving.

2.1.7 Gate Leaf Position Indicator

2.1.7.1 Mechanical Position Indicator

The mechanical position indicator gage shall be constructed of 12-gauge brass plate and shall be rigidly and securely attached to the hydraulic cylinder. The gage shall be graduated into major, minor and intermediate divisions. Major divisions shall be 1 foot apart, minor divisions shall be one tenth of a foot apart, and intermediate divisions shall be 6 inches apart. Letters, numerals, and divisions shall be marked on the gate by cutting or etching into the gage. Letters shall be 1/2 inch high by 3/8 inch wide, numerals shall be 3/4 inch high by 5/8 inch wide. Major divisions shall be 2-1/2 inches long, minor divisions shall be 1-1/2 inches long and intermediate divisions shall be 2 inches long. All letters, numerals and divisions shall be 1/8 inch thick. Major divisions shall be marked to indicate gate opening in feet. Intermediate divisions shall be placed to indicate one half foot increments. Gages shall be black enamel on white enamel background and baked. The enamel shall conform to FS TT-E-489, Class B. The closed position of the gate shall be accurately determined and the indicator shall be so mounted that the indicator pointer

reads "0" when the gate is closed. Each gage shall have "Latched" position shown above the normal raised position mark, verified to indicate that the gate is in the latched position.

2.1.7.2 Remote Indicating System

In addition to the mechanical indicators, each service gate shall be equipped with a remote indicating system to be installed as specified in SECTION 16051: ELECTRICAL CONTROL SYSTEMS.

2.2 SPECIAL TOOLS TO BE FURNISHED

The Contractor shall furnish all special tools required for disassembly and maintenance of the equipment. In addition, a slugging wrench shall be furnished for the gate leaf nuts and spanner wrenches for the operator piston, latch piston and latch release. The latch piston and latch release spanner wrenches shall be extended to work in the latch body. A complete list of special tools shall be furnished by the Contractor with his Bid.

2.3 SPARE PARTS

A set of spare parts as recommended by the manufacturer shall be supplied. All spare parts shall be duplicates of the original parts they are intended to replace. Each spare part shall bear a tag or label securely attached clearly identifying the component for which it is intended. Spare parts shall include as a minimum:

1. One spare set of all rubber or neoprene seals and packings.

2. One spare stem nut and stem packings.

3. One spare set of packings for bonnet cover.

4. Ten percent of all bolts and fasteners.

PART 3 EXECUTION

3.1 GATES, SEALS AND STEM ALIGNMENTS

Each seal on gate frame shall not deviate from a true pane surface by more than 0.003 inch in any 4-foot length. Clearance between the gate sealing surface and frame seals with the leaf in the closed position shall not be more than 0.006 inch. The centerline of the stem shall not deviate more than 0.020 inch from the average plane of the gate leaf seals in any 10-foot length. There shall be no binding of the gate seals when the gate is in the raised position. End guides on the gate shall be parallel to the centerline of the gate stem with an allowable tolerance of not more than 0.060 inch in any 8 feet.

3.2 TESTING

3.2.1 Shop Assembly and Testing

3.2.1.1 Assembly

Each gate shall be completely assembled in operating position in the shop for inspection and to insure that all parts fit accurately and are in proper alignment and to the tolerances specified in paragraph: GATES, SEALS AND STEM ALIGNMENTS.

3.2.1.2 No-Load Raise

Gates shall first be assembled without the cylinder head. Oil shall be admitted to the underside of the piston at a maximum pressure of 125 pounds per square inch or as determined in the final design which should raise the leaf to the full open position. A higher pressure than the above would indicate undue binding and shall be cause for rejection.

3.2.1.3 Piston Leakage

The pressure shall then be released and the gate leaf allowed to lower by gravity against a controlled flow from the cylinder. Refusal of the gate to lower by gravity will indicate undue binding and shall be cause for rejection. The gate shall again be raised and a test pressure of 2,000 psi shall be held on the underside of the piston for 15 minutes. The maximum allowable flow past the piston rings shall be two pints during the 15-minute period. Oil used for the test shall be the same as for operation.

3.2.1.4 Latch Mechanism

The cylinder head shall then be installed using 8 head bolts, equally spaced. The gate hangers shall be tested by the application of 50 psi of oil on the top of the piston for 5 minutes with the latch line vented and the air vented from the head. Pressure shall then be lowered to 25 psi and the latch release line connected to a source of 1,000 psi of oil to raise the latch piston and unlatch the gate. The source of the unlatching pressure shall be an accumulator to raise the latch piston within one second and to hold the latch piston in the raised position until the latch tines are out of the latch body. The head shall then be removed and the mechanism inspected for any deformation, galling, or looseness.

3.2.1.5 Gate Leakage

The regulating gate shall be bolted together with the gate frame in its normal position and leakage test performed with 15 psi pressure at gate centerline. A nominal leakage of two gallons in ten minutes shall be allowed providing the water is not jetting by the seal plates or sills.

3.2.1.6 Defects

The presence of any of the malfunctions mentioned in the preceding paragraphs or defects that affect the performance of the product shall be corrected and approved prior to delivery to the job site.

3.2.1.7 Marking

All parts of each slide gate assembly shall be marked and match-marked for identification to facilitate field erection and, in addition, all parts of each assembly shall be marked for ready identification with the proper assembly and to show the relative position of the part in the assembly. A diagram of such marking shall be submitted for approval. All joints shall be shop fitting and match-marked before shipping.

3.2.2 Field Testing

These tests shall be made with a dry conduit. After installation of the gates, with all piping and controls complete, a test for tightness of the system shall be made at 1,800 psi with the entire system full of oil that

has been cleaned and all trapped air bled from the system. For the test, the bypass valves shall be set at 1,800 psi and the counterbalance valves shall be set at 800 psi. The seal bars shall be coated with light grease. Operating one gate at a time, each gate shall be raised to the full open position and the pressure maintained by allowing the oil to bypass for a minimum of 15 minutes. The gate shall then be lowered to the closed position and the pressure maintained for a minimum of 5 minutes. The pumps shall be alternated for each gate test. After the completion of this test and after all leads have been made tight, each gate shall be operated through four cycles. The leaf shall travel smoothly with no tendency to chatter through the entire range of the leaf travel. Motor and interconnecting wiring shall be tested in accordance with SECTION 16415: ELECTRICAL WORK, INTERIOR. Electrical controls and indicators shall function and all valves and the entire gate system shall operate in accordance with the requirements of the specification drawings and specifications.

3.3 PAINTING

The slide gates shall be dismantled as required and cleaned as specified on the specification drawings and in SECTION 09940: PAINTING: HYDRAULIC STRUCTURES AND APPURTENANT WORKS before painting as follows: The non-embedded ferrous surfaces of the bonnets, air vents, frames and the inside surface of the bonnet covers and the entire area of all gate leaves shall be painted according to paint system 4. Seals shall not be painted. The embedded surfaces of the bonnets and frames shall not be painted. The outside surfaces of the bonnet covers shall be painted according to paint system 16. Stainless steel surfaces shall not be painted.

3.4 SHIPPING

All unpainted finished surfaces exposed to the atmosphere during shipment shall be coated with a corrosion preventive compound in accordance with the manufacturer's written recommendations and approved by the Contracting Officer. The interior surfaces of all hoist cylinders and the gate latches shall be coated with corrosion preventive compound in accordance with the manufacturer's written recommendations and approved by the Contracting Officer.

3.5 STORAGE

If the slide gates are assembled when shipped, the Contractor may store the assembled slide gates outdoors. The slide gates shall rest on timbers so that no part of the assembly is in contact with the ground. If the slide gates are not assembled when shipped, the pistons, gate stems, cylinders and cylinder heads shall be stored indoors and not in contact with the earth. The frames, bonnets, leaves, and bonnet covers may be stored outdoors and shall rest on timber so that no part is in contact with the ground. All electrical and hydraulic parts, including the hydraulic piping, shall be stored in a heated warehouse. The hydraulic piping and welded piping subassemblies as supplied, with the power unit, shall have been pickled, solvent cleaned, blown out with clean dry air and plugged. Care shall be taken during handling, storage and installation to keep the pipe and tubing interiors clean. The oil reservoir shall be inspected before installation in the presence of the Contracting Officer, and cleaned if requested.

3.6 INSTALLATION

The gate members shall be erected in strict conformity with the match marks, taper pins and dowels used at the time of shop assembly. The parts shall be aligned with the taper pins and dowels and then bolted together. Two prints of the match marked drawings shall be shipped with the slide gates. The gate frames and bonnet frames shall be held rigidly in place, true to grade, line and height, until placing of the concrete is completed. The gate frame and bonnet seals surfaces shall be set and maintained so that no part of the sealing surfaces shall deviate from a vertical plumb plane by more than 0.010 inch provided that the deviation shall not exceed more than 0.002 inch per foot. During installation, all bolts shall be tightened by calibrated torque wrenches. The torque reading of wrenches shall be approved. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to retighten bolts which may have been loosened by the tightening of subsequent bolts, until all bolts are tightened to the prescribed amount. The outside surfaces of the gate frames, bonnets and other parts to be embedded in concrete shall be cleaned of all rust, grease and dirt before the concrete is placed. After installation, all gate frames, conduit linings and similar parts shall be tested with a hammer to detect possible voids in adjacent concrete. Three-fourths-inch NPT holes shall be drilled and tapped in the frames and similar parts if voids are detected. Voids shall be grouted and the grout holes shall be fitted with solid steel pipe plugs and ground smooth. Grouting pressures shall not exceed 50 psi. After all concreting and/or grouting operations have been completed, a survey shall be conducted to determine whether or not the above specified tolerances have been maintained. If the specified tolerances have not been maintained, such corrective action shall be taken as directed or approved by the Contracting Officer.

3.7 HYDRAULIC OIL CLEANING

The Contractor shall furnish an oil purifier for cleaning the hydraulic oil upon completion of the installation. The oil purifier shall be erected and operated as specified. Oil shall be taken from the sump drain, passed through the purifier and discharged back into the sump through the fill opening. The gates shall be operated to insure that all oil in the hydraulic system passes through the purifier and this process shall continue until the total sediment and water of the purified sample does not exceed 0.05 percent when tested in accordance with test method outlined by ASTM D 1796. A one-half gallon sample shall be taken and sent to an independent laboratory and tested. New purifier filters shall be furnished by the Contractor.

3.8 ELECTRICAL EQUIPMENT

The Contractor shall install the control stations, pump motors, remote indicators, interconnecting wiring, conduit and electrical devices as part of the slide gate installation in accordance with the applicable provisions of SECTION 16415: ELECTRICAL WORK, INTERIOR, and as shown on the contract drawings and manufacturer's approved shop drawings.

3.9 VALVE SETTINGS

After field tests of gates and controls are completed, the following settings shall be made for operating conditions: Pressure relief valves shall be set at 2,000 psi. Pressure switch shall be set at 1,800 psi.

3.10 SERVICES OF ERECTION ENGINEER(S)

The gate supplier shall be required to provide one or more competent erection engineer who shall supervise and be responsible for the correctness of the contractor's assembly procedures, method of alignment, installation of equipment and testing. When so requested, he shall also supervise and be responsible for initial starting and all subsequent operation of the equipment until the field tests are completed. The erection engineer shall instruct the Contracting Officer for a minimum of one full day, in the operation and maintenance features of the equipment. The erection engineer shall cooperate fully with the Contractor, however, the work and operation of the manufacturer's representative shall be directed by the Contracting Officer. The Contracting Officer shall be given 30 calendar days advance notice of the time when such services of the manufacturer's representative shall be needed and the Contractor shall be held responsible for any work done in the absence of the manufacturer's representative. Any errors in work done, or work which does not conform to the instructions issued by the manufacturer, shall be corrected at no cost to the Government.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15098

BUTTERFLY SHUTOFF VALVE, OPERATORS AND ACCESSORIES

-- End of Section Table of Contents --

SECTION 15098

BUTTERFLY SHUTOFF VALVE, OPERATORS AND ACCESSORIES

PART 1 GENERAL

1.1 GENERAL INFORMATION

The Contractor shall furnish, install and test a 36-inch diameter butterfly valve complete with electric operator, fittings and accessories. The valve shall be installed in the low flow outlet pipeline upstream of the knife gate valve in the valve vault as shown on the specification drawings or as directed, complete with all accessories.

1.2 REFERENCES

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest revisions and versions shall be followed regardless of the date shown.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B16.1	(1988) Pipe Flanges and Flanged Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C504	(1994) Rubber Seated Butterfly Valves
AWWA C507	(1991) Test Methods for Butterfly Valves

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 193	(2000) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 536	(1999el) Ductile Iron Castings
ASTM D 429	(1981) Test Methods for Rubber Property - Adhesion to Rigid Substrates

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G

Drawings include design calculations, catalog cuts, templates, fabrication, and assembly details, and type, grade, and class of materials, as appropriate. Elements of fabricated items, inadvertently omitted on specification drawings, shall be detailed by the fabricator and indicated on the shop drawings.

SD-03 Product Data

Materials; G

Two copies of all purchase and mill orders, shop orders for materials, and work orders. At the time of submittal of shop drawings, a list shall be furnished designating the material to be used for each item. The purchase orders shall contain the original mill test report, the test site address, and the name of the testing agency.

SD-05 Design Data

Welding Procedures; G

A complete schedule of welding procedures, if applicable, consisting of detailed procedure specifications and tables or diagrams showing the procedure to be used for each required joint.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual; G

Manuals shall be submitted which contain operating instructions, maintenance instructions, and parts catalogs for all equipment provided under this section of the specifications. Data shall be bound and labeled, "Butterfly Shutoff Valve Operation and Maintenance Data".

1.4 QUALITY CONTROL

The Contractor shall ensure that required tests, workmanship, and other performance aspects of the work comply with the applicable quality control requirements specified herein. In accordance with FAR 52.246-2, INSPECTION AND ACCEPTANCE, the Contractor shall provide continuous inspection of all operations for quality control and record the result for submittal to the Contracting Officer to show compliance with the contract requirements.

1.5 TYPE OF SERVICE

The valve is intended for full close and full open service and not for prolonged throttling.

The valve shall be used to shut off flow from Prado Dam reservoir whenever needed to isolate the knife gate throttling valve for emergency, maintenance or repairs.

The valve shall be capable of emergency closure under maximum discharge of 250 cubic feet per second through the low flow outlet without vibrations

and cavitation. The valve shall be able to withstand the consequent flow velocities in its normal open position without cavitation and vibration for continuous periods of operation, usually about 3 months during a year.

1.6 GUARANTEE

The butterfly valve and motor operator furnished under this section of the specification shall be guaranteed to be free from defects in materials, design, workmanship, installation, and operation for a period of 5 years from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier. Upon receipt of notice from the Contracting Officer of failure of this equipment during the guarantee period, new replacement parts shall be furnished and installed promptly. Such repairs shall restore the operation of the valve and motor operator to their original level. The guarantee on replacement parts or equipment shall be extended for a period of 1 year from the date of replacement acceptance.

PART 2 PRODUCTS

2.1 BUTTERFLY VALVE

The butterfly valve shall be of the rubber or elastomer seated type with bubbletight shutoff at the rated pressure. The valve shall satisfy or exceed the requirements of ANSI/AWWA Standard C504, Class 150, including Appendix A. The valve shall be provided with ANSI 150 pound flanges. The valve shall be furnished complete with operator, position indicator, floor stand, anchor bolts, fasteners and all accessories. The valve shall be suitable for operation after long periods of inactivity.

Valve shall be Keystone Figure 504 with short body (9-inch laying length or less) with operator as manufactured by Keystone Valve, Houston, Texas, or equal.

The valve shall be provided with a minimum of two lifting eyes.

Seismic forces shall be accounted for in the design based upon earthquake forces determined in accordance with Section 13080 of these Specifications.

2.2 MOTOR OPERATOR

2.2.1 General

The valve operator shall be a sealed design suitable for submergible service and shall include the electric motor, motor winding heater, terminal blocks, reduction gearing, torque switches, enclosure heater, and limit switches in one assembly. The motor controls will be located on the hydraulic equipment platform at Elevation 512.0. Motor starters will be located in the emergency motor control center in the control room at Elevation 596.0. The reduction gearing shall consist of helical gears of heat-treated steel and a worm of hardened alloy steel with ground and polished threads meshing with a worm gear of high tensile bronze. The gearing shall have a service rating factor of 1.50. All reduction gearing shall run in lubricant. Anti-friction bearings shall be used throughout. The operator shall be constructed with a built-in lost motion device which shall permit the motor to attain full speed in both directions before imparting a hammer blow to initiate motion. The operator shall have a handwheel capable of being operated to open or close the valves in case or electric power failure. The handwheel shall automatically declutch in case

the power returns to prevent injury to personnel. The maximum rimpull force required to operate the handwheel shall not exceed 60 pounds. The motor operator shall be of an approved design equal in construction to those which have operated successfully in similar installations (i.e. similar valve size and operating conditions) for a period of at least 5 years. Evidence shall be submitted of three such installations, including names, addresses, and telephone numbers of owners. Motor operator shall be mounted and tested in the valve manufacturer's factory.

The valve actuator shall consist of a 120-volt A.C., single-phase permanent split capacitor, reversible type electric motor which drives a compound epicyclic gear. The electric actuator shall have visual, mechanical indication (readable from a distance of 25 feet), showing output shaft and valve position. Unit shall be capable of mounting directly to butterfly valves without brackets and adapters, readily adapted to suit all other types of 1/4-turn valves. The actuator shall have an integral, terminal strip which, through conduit entry, will insure simple wiring to power supplies. The actuator shall have a self-locking gear train which is permanently lubricated at the factory. Motor breaks shall not be permitted. The gearing shall be run on ball and needle bearings. The actuator shall have two adjustable mechanical torque limit switches of the single-pole, double-throw type. The motor shall be fitted with thermal overload protection. Motor rotor shaft shall run in ball bearings at each end of motor. The housing shall be epoxy coated high strength ductile iron for full environmental protection. The actuator shall have an integral self-locking manual override. Levels or latches shall not be required to engage or disengage manual override.

The operator shall be equipped with a handwheel and 2-inch square operating nut.

The operator shall be worm geared, lubricated and sealed to prevent entry of dirt or water into the operator.

2.2.2 Electric Motors

The motor shall be of the high torque type, totally enclosed, and of valve duty construction. Insulation shall be NEMA Class F with Class B thermal overload sensors imbedded in the motor windings. The motor shall be wired for 480 volt, 3-phase power. All motor bearings shall be of the anti-friction type and shall be prelubricated. The motor shall be capable of running at full load torque which is equal to 40 percent of the rated locked rotor torque for a 15-minute duty cycle without exceeding NEMA Class B limitation. The electric motor operator shall be sized and geared to open the valve in a period of 3 minutes against a head of 534 feet and to close the valve in a period of 3 minutes against a head of 534 feet. The motor enclosure shall meet NEMA 6 for submersible service.

2.2.3 Nameplates

The motor and the operator shall have a standard nameplate securely affixed thereto in a conspicuous place. Care shall be taken not to paint over or otherwise obscure the nameplate data. Nameplates shall show the manufacturer's name, the model and serial numbers.

2.2.4 Position Limit Switches

Position limit switches and the associated gearing shall be an integral part of the valve actuator. Switches shall be activated by a rotor type

design. The limit switch gear mechanism shall be enclosed to prevent entrance of dirt and foreign matter. Switches shall be adjustable, allowing for trip points from full open to fully closed positions of valve travel. They shall not be subject to breakage or slippage due to over-travel. Limit switch contacts shall be heavy duty, gold-plated silver with wiping action. The actuators shall have 8 electrically separate contacts field adjustable from normally open (N/O) to normally closed (N/C) or reverse. Limit switches shall be rated 10 ampere, 120 volt A.C.

2.2.5 Heaters

Strip-type heaters for operation on 120 volts A.C. shall be rated for 240 volts A.C. and shall be provided in the actuator housing. Heaters shall be sized to maintain the respective equipment's temperature 10 degrees F above ambient temperature not to exceed 135 degrees.

2.2.6 Pushbutton Control Station

The pushbutton control station shall be furnished for direct mounting to the electric actuator. Three double "O" rings sealed pushbuttons labeled "OPEN", "CLOSED", "STOP", one selector switch labeled "LOCAL", "OFF", "REMOTE", and two LED indicating lamps, RED for open and GREEN for closed, shall be furnished for the pushbutton control station. A power on LED pilot light shall also be furnished on the actuator. The pushbutton station shall be suitable for weatherproof, and submersible service:

1. Weatherproof - NEMA 1, 2, 3, 4, 6 and 12.

2. Submersible - Suitable for 150-foot head of water for 24 hours.

Indicating lamps shall be high intensity LED type. The selector switch shall have a minimum of two electrical separate contacts for each position. The pushbutton and selector switch contacts shall be rated for 120-volt, 50/60 Hertz, single-phase, 10 amperes continuous current.

2.2.7 Mechanical Position Indicator

A mechanical position indicator shall be furnished. The mechanical indicator shall be an easily readable pointer dial calibrated from 0 to 100 percent corresponding to 0 to 100 percent valve position. Electronic or electrical indication for this dial is not acceptable.

2.2.8 Torque Switch

Each valve actuator shall be equipped with a switch that will interrupt the control circuit in both the opening and closing directions when valve torque overload occurs or when valves require torque switch setting in the closed or open position. The torque switch shall have graduated dials for both open and closed directions of travel and each shall be independently adjustable, with a positive means to limit the adjustability so as to not exceed the actuator output torque capability. Mechanical torque springs for load control shall be field replaceable without need of actuator dismantling or removal of the worm assembly.

2.3 MATERIALS

2.3.1 Body

Valve body shall be constructed of ductile iron ASTM A 536, Grade 65-45-12,

with ANSI B16.1, Class 150 pound flange drilling. Body shall be completely sealed from the media by elastomeric body seat.

2.3.2 Disc

Valve disc shall be constructed of ductile iron ASTM A 536, Grade 65-45-12 with a 316 stainless steel or a monel disc edge.

2.3.3 Shaft

Shaft shall be 18-8 series stainless steel, corresponding to the design requirements of AWWA C504, latest revision. The shaft shall fasten to the disc by means of a torque plug designed to provide a shakeproof connection without impairing shaft strength.

2.3.4 Valve Seats

Valve seats shall be a full circle 360 seat located in the body only and shall be of a synthetic rubber compound, hard backed with bonding tested in accordance with ASTM D 429, Method B, suitable for service. Manufacturer shall certify that rubber seat is field replaceable, without the use of special tools. Seat shall also provide gasket surface for mating flanges.

2.3.5 Bearings

All shaft bearings shall be of the self-lubricating, corrosion-resistant, sleeve type. Bearings shall be designed for horizontal and/or vertical shaft loading.

2.3.6 Packing

Valve shall have self-adjusting packing. The packing shall be replaceable without removing the valve actuator.

2.3.7 Testing

All valves shall be hydrostatic and leak tested in accordance with AWWA C504, latest version.

2.4 GASKETS AND HARDWARE

All nuts, bolts, washers, gaskets and other hardware required for installation of the valve, spool pieces and accessories shall be furnished with the valve. Hardware shall be in accordance with ASTM A 307, Grade B or ASTM A 193, Grade B7, hot-dipped galvanized after fabrication. Gaskets shall be 1/8-inch cloth inserted rubber, full face.

2.5 PAINTING

All non-corrosion resisting surfaces shall be prepared and painted according to System No. 2 described in SECTION 09940: PAINTING HYDRAULIC STRUCTURES AND APPURTENANT WORKS or approved equal. All painted surfaces shall be protected from abrasion and damage at all times.

PART 3 EXECUTION

3.1 TOOLS

One set of any special tools required for assembly or disassembly of any of

the equipment being supplied shall be furnished on an approved tool board. This shall include all spanners, sockets, drifts, and pullers necessary for the removal and complete dismantling of the valve and operator.

3.2 SPARE PARTS

One complete set of packings, gaskets, glands, bushings, seals, tapered pins and keys, and packing seats shall be provided for each valve. All spare parts shall be duplicates of the original parts they intended top replace. Each spare part shall bear a tag or label securely attached clearly identifying the component for which it is intended. One extra motor starter, torque switch, and limit switch shall be provided for the valve operator.

3.3 ELECTRICAL EQUIPMENT

All electrical devices shall be installed as part of the valve installation in accordance with SECTION 16415: ELECTRICAL WORK, INTERIOR and SECTION 16052 - CONTROL SYSTEM - LOW FLOW OUTLET, THROTTLING AND SHUTOFF VALVES, and as shown on the specification drawings and manufacturer's approved shop drawings.

3.4 SERVICES OF ERECTING ENGINEERS

The valve supplier shall be required to provide one or more competent field service engineers who shall supervise and be responsible for the correctness of the Contractor's method of alignment and installation of equipment and testing. When so requested, the field service engineer shall also supervise and be responsible for initial starting and all subsequent operation of the equipment until the field tests are completed. He shall instruct the Contracting Officer's representatives, for a minimum of one full day, in the operation and maintenance features of the work. He shall cooperate fully with the Contractor, however, the work and operation of the field service engineer shall be as directed by the Contracting Officer. The Contracting Officer shall be given 30 calendar days advance notice of the time when such services of the field service engineer shall be needed and the Contractor shall be held responsible for any work done in the absence of the field service engineer. Any errors in work done in the absence of the field service engineer, or work which does not conform to the instructions issued by such erecting engineer(s) shall be furnished at no extra cost to the Government for such reasonable time as determined necessary. The field service engineer and the Contractor's erecting engineers shall, throughout the installation and testing of the valve, comply with all accident prevention procedures as directed.

3.5 ACCEPTANCE TESTING

3.5.1 General

The previous paragraphs specifying the butterfly valve and motor operator set forth minimum requirements. The motor operator shall be installed on the ball valve at the valve manufacturer's factory. The valve and motor operator provided shall operate smoothly, quietly, and free from any chattering, noticeable vibration or periodic noises under the full range of head conditions. Failure to conform to this requirements shall be grounds for rejection of that particular valve and operator combination.

3.5.2 Butterfly Valve

At the factory before installation, each butterfly valve shall be subjected to a hydrostatic pressure of 100 psi with the plug in the opened position and both ends bulkheaded. This pressure shall be held for a minimum of 30 minutes during which time valve parts shall show no evidence of distress or weeping. Each valve shall then be bulkheaded on the upstream side and subjected to a hydrostatic pressure of 300 psi in the closed position. The pressure shall be held for a minimum of 15 minutes. Leakage past the seat shall not exceed 0.5 pint per minute. The valve shall also be tested at 150 psi in the open position. All tests shall conform to AWWA C507. The valve shall pass these tests before acceptance is given. The valve shall not be disassembled once test acceptance is given. Blind flanges or bulkheads necessary for the pressure test shall be furnished by the Contractor.

3.5.3 Field Testing

After installation, the Contractor shall test the valve for 1.25 times the maximum design pressure. The valve shall be bubbletight when subjected to the test pressure for at least 15 minutes. The Contractor shall demonstrate that the valve will operate smoothly under the maximum unbalanced design pressure specified.

3.6 QUALITY ASSURANCE

In accordance with SC-30, the materials, installation and testing shall be inspected for compliance with the Contract requirements.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15099

LOW FLOW OUTLET KNIFE GATE THROTTLING VALVES AND OPERATORS

-- End of Section Table of Contents --

SECTION 15099

LOW FLOW OUTLET KNIFE GATE THROTTLING VALVES AND OPERATORS

PART 1 GENERAL

1.1 GENERAL INFORMATION

1.1.1 General

The work covered in this section consists of furnishing all plant, labor, materials, and equipment; and performing all work required to design, furnish, paint, and install two (2) electric motor operated 36-inch, knife gate valves, operators, and appurtenant equipment in the low flow outlet works of Prado Dam. All work shall be in accordance with the drawings and these specifications.

1.1.2 Operating Conditions

The detailed requirements described herein are for throttling valves which hereinafter shall be referred to as "valves". The valves shall be bolted to flanges located in the low flow outlet pipes and shall be used to regulate the flow of water through the conduit. The primary concern in the design and operation of the valves is reliability. Each valve shall be designed and installed to operate free from injurious structural vibration at any position between fully closed and fully opened and shall have no tendency to drift either closed or open at any position. The design of each valve shall incorporate full consideration of the approach conditions as well as the total hydraulic layout for the system. The valves will be used on a near-continuous basis. The head and discharge ranges under which the valves shall operate is given below.

Maximum Static Head	126 feet
Maximum Operating Head	96 feet of water to sill
Minimum Downstream Head	0 feet of water
Normal Operating Discharge Per Each Valve	0 - 125 cubic feet per second
Maximum Operating Discharge Range for Each Valve	0 - 250 cubic feet per second
Accuracy Required for Discharge Throttling	1 percent or less

Seismic forces shall be calculated and included in the design in accordance with the requirements of Section 13080 of these specifications.

1.1.3 Capacity

The normal required capacity of the system of valves is 125 cubic feet per

second at 95 feet of head with the capacity to release a minimum of 1 cubic foot per second. The maximum required capacity in case of shutdown of one of the low flow outlets is 250 cubic feet per second.

1.1.4 Valve Supplier Qualification

1.1.4.1 General

Due to potential operational problems with knife gate valve installations, the Contractor shall use valves of appropriate design. To assure this, the Contractor is required to have the Contracting Officer approve the qualifications of the proposed valve supplier before proceeding with valve fabrication. Therefore, 60 days prior to submittal of shop drawings, a statement by the proposed valve supplier shall be submitted that the supplier's valve design is a "proven or dependable design". Specifically, the statement shall verify that the supplier has furnished valves of the similar size and design which have operated successfully under essentially similar operating conditions for a minimum of five years.

1.1.4.2 Normal Flow Velocities

Normal flow velocities in valves of such "proven design" shall have equalled or exceeded those intended for the valves in this contract. The statement shall give the location, owner's name and telephone number, and rating of the valves and the years in which the valves were manufactured, installed, and successfully operated for at least two separate installations. In addition, data on the proposed valve supplier's present manufacturing and testing facilities shall be submitted; these data shall be considered in determining whether each manufacturer is qualified to perform the work. Failure of the Contractor to comply fully with these requirements, or failure of the submitted data to demonstrate to the satisfaction of the Contracting Officer, the supplier's compliance with these Specifications, shall result in disqualification of the supplier.

1.2 REFERENCES

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest revisions and versions shall be followed regardless of the date shown.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B2.1	(1990) Pipe Threads (Except Dry Seal)Specifications, Dimensions, and Gaging for Taper and Straight Pipe Threads

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 193	(2000) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 276	(1998) Stainless Steel Bars and Shapes
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 743	(1995) Corrosion-Resistant

Iron-Chromium-Nickel and Nickel-Based
Alloy Castings for General Applications

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G

Drawings include catalog cuts, templates, fabrication and assembly details, and type, grade, and class of materials, as appropriate. Elements of fabricated items inadvertently omitted on specification drawings shall be detailed by the fabricator and indicated on the shop drawings. Such data shall include, but not be limited to, valve-operating curves which show discharge in cfs versus net head in feet for each valve for valve gate positions from 10 to 100 percent in 10-percent increments. Curves shall be shown on reproducible 18-inch by 24-inch graph paper.

SD-03 Product Data

List of Materials; G

Two copies of all purchase and mill orders, shop orders for materials, and work orders. At the time of submittal of shop drawings, a list shall be furnished designating the material to be used for each item. The purchase orders shall contain the original mill test report, the test site address, and the name of the testing agency.

SD-05 Design Data

Welding Procedures; G

A complete schedule of welding procedures consisting of detailed procedure specifications for each cone valve and spool piece to be welded and tables or diagrams showing the procedure to be used for each required joint.

SD-07 Certificates

Certificate

Results of field and factory pressure tests and operational tests shall be submitted within 7 days after completion.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual; G

Manuals shall be submitted which contain operating instructions, maintenance instructions, and parts catalogs for all equipment provided under this section of the specifications. Operations and

maintenance data shall be bound and labelled: "Knife Gate Valve Operation and Maintenance Data".

1.4 GUARANTEE

The valves, operating mechanisms, and operators and controls furnished under this section of the specifications shall be guaranteed to be free from defects in materials, design, workmanship, installation, and operation for a period of five years from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier. Upon receipt of notice from the Contracting Officer of failure of any part of this equipment during the guarantee period, new replacement parts shall be furnished and installed promptly. Such repairs shall restore the operation of the valves and operators to their original level. The guarantee on replacement parts or equipment shall be extended for a period of one year from the date of replacement acceptance.

PART 2 PRODUCTS

2.1 KNIFE GATE VALVES

2.1.1 General

Unless otherwise specified, the workmanship and materials shall conform to the applicable provisions of SECTION 05501: METALWORK FABRICATION, MACHINE WORK AND MISCELLANEOUS PROVISIONS and as specified on the specification drawings. The valves shall be installed in accordance with the critical installation dimensions shown on the manufacturer's approved drawings.

2.1.2 Construction

The standard port cast body knife gate valve shall be of stainless steel 316SS construction. The stem nut shall be of 304 stainless steel. The nuts for packing gland bolting shall have a nylon insert anti-vibration feature. Chest buttons and/or centerline buttons shall be provided for low pressure sealing by holding the gate in close alignment with the seats at all gate positions. The tips of the chest and centerline button shall contain a nylon insert (PTFE) or brass insert of approved quality.

The valve shall be provided with flush parts suitable for flushing using liquid or compressed air to flush out debris collected in the bottom or chest area of the valve. There shall be at least five flush ports per knife gate valve, two in the chest and one at bottom, two each at 45 degrees from the bottom or as recommended by the manufacturer. The flush ports shall be hydrotested in the shop and filled with reuseable plugs.

The valve seats shall be of corrosion and abrasion resistant materials and shall be replaceable.

The pressure rating of the valve including bonnet materials shall be for 150 psi CWP.

Unless otherwise approved by the Contracting Officer, the following materials shall be used in the construction of knife gate valve and components.

Item	Material	Specifications
Body, Chest and Flange	Cast Stainless Steel	ASTM A 743

Item	Material	Specifications
		Grade CF-8M Type 316
Bonnet	Stainless Steel	ASTM A 276 Type 316
Seat	Integral	Nitronic 60
Gate	Stainless Steel Finished 32 RMS	ASTM A 276 Type 316
Yoke	Stainless Steel	ASTM A 276 Type 316
Yoke Fasteners	Stainless Steel	
Stem	Stainless Steel	ASTM A 276 Type 316
Lubrication Fitting	Stainless Steel	
Packing	PTFE/Graphite	
Packing Follower	Stainless Steel with Stainless Steel Bolting	ASTM A 276 Type 316

The Contractor may propose alternative materials along with complete justification, specifications and data for such proposed substitutions.

2.1.3 Anchor Bolts

Anchor bolts shall be in accordance with SECTION 05120: STRUCTURAL STEEL AND MISCELLANEOUS METAL.

2.1.4 Concrete Anchors

Concrete anchors shall be in accordance with SECTION 05120: STRUCTURAL STEEL AND MISCELLANEOUS METAL. Where the attached or suspended equipment does not bear directly on the concrete, an OG washer or heavy steel or malleable-iron washer and nut shall be used to provide a constant loading on the anchor. Safe working loads shall be computed at 25 percent of the proof load test.

2.1.5 Operating Mechanisms

The operating mechanism shall be mounted on the valve and shall apply operating forces on the valve gate at the centerline of the valve. Torque from the motor operator shall be transmitted by extended drive shafting through an oil or grease lubricated miter gear box mounted on the valve body to oil or grease lubricated worm or bevel gear boxes located on the valve body or by an approved equivalent method. Stainless steel or high tensile bronze operator screw stem with machined threads (for a close running fit in the bronze nuts) shall control the valve gate through bronze nut (with machined threads, equipped for grease lubrication) mounted on the gate flange. All gear boxes shall be adequately sealed against the ingress of water. The operator screw stem shall be adequately protected against water, dirt, and mechanical damage by steel pipe covers, fabric bellows, telescopic tubes, or a combination thereof. The supplier shall certify that the operating mechanism is of a proven design which has operated successfully in similar installations (i.e., cone valve size and operating conditions) for a period of at least 5 years, and shall give details, locations, owners' names and telephone number for at least three such installations. Drawings shall be shall be mounted. The method chosen shall enable satisfactory torque transmission from the motor operator.

2.1.6 Lubrication

Stainless steel tubing of an adequate diameter and wall thickness shall be provided for the valve to facilitate convenient lubrication of such components and areas requiring lubrication. Tubing shall extend from each grease fitting and terminate at a solid, protected, and easily accessible location near each valve operator. Flexible connections shall be provided into each valve assembly. Buttonhead grease fittings (5/8 inch) shall be used.

2.2 MOTOR OPERATORS

2.2.1 General

Each valve operator shall be a sealed design suitable for submerged service and shall include an electric motor, motor winding heater, terminal blocks, reduction gearing, torque switches, enclosure heater, position transmitters and limit switches in one assembly. The motor controls and position indicators shall be located on the hydraulic equipment platform at Elevation 512.0. Motor starters will be located in the emergency motor control center in the control room at Elevation 596.0. All wiring and controls shall conform to the requirements of specification SECTION 16415: ELECTRICAL WORK, INTERIOR. The reduction gearing shall consist of helical gears of heat-treated steel and a worm of hardened alloy steel with ground and polished threads meshing with a worm gear of high tensile bronze. The gearing shall have a service rating factor of 1.50. Normal running torque of the motor operator shall be at least 1.25 times the maximum torque required to operate the valve. All reduction gearing shall run in lubricant. Anti-friction bearings shall be used throughout. Each operator shall be constructed with a built-in lost motion device which shall permit the motor to attain full speed in both directions before imparting a hammer blow to initiate motion. Each operator shall have a handwheel capable of being operated to open or close the valves in case of electric power failure. The handwheel shall automatically declutch in case the power returns to prevent injury to personnel. The maximum rimpull force required to operate the handwheel shall not exceed 60 pounds. Certification and written evidence shall be given that each motor operator is of an approved design which has operated successfully in similar installations (i.e., knife gate valve size and operating conditions) for a period of at least five years.

2.2.2 Electric Motors

Each motor shall be of the high torque type, totally enclosed non-ventilated, and of heavy duty construction. Insulation shall be NEMA Class F with Class B thermal overload sensors embedded in the motor windings. Each motor shall be wired for 480 volt, 3-phase power. All motor bearings shall be of the anti-friction type and shall be prelubricated. The motor shall be capable of running at full load torque which is equal to 40 percent of the rated locked rotor torque for a 15-minute duty cycle without exceeding NEMA Class B limitation. Each electric motor operator shall be sized and geared to open knife gate valve in a period of about 3 minutes against a head of 96 feet to the sill, and to close the valve in a period of about 3 minutes against a head of 96 feet above the sill. The motor enclosure shall meet NEMA 6 for submersible service.

2.2.3 Nameplates

Each motor and each operator shall have a standard nameplate securely affixed thereto in a conspicuous place. Care shall be taken not to paint

over or otherwise obscure the nameplate data. Nameplates shall show the manufacturer's name, the model and serial numbers, and the following information:

1. Motor Nameplate. Frame size, full load hp, rpm, voltage, cycles, amps, duty cycle, temperature rise above ambient, locked rotor torque.

2. Operator overall gear ratio, input and output torque ratings.

2.2.4 Position Limit Switches

Position limit switches and the associated gearing shall be an integral part of the valve actuator. Switches shall be activated by a rotor type design. The limit switch gear mechanism shall be enclosed to prevent entrance of dirt and foreign matter. Switches shall be adjustable, allowing for trip points from fully open to fully closed positions of valve travel. They shall not be subject to breakage or slippage due to over-travel. Limit switch contacts shall be heavyduty, gold plated silver with wiping action. The actuators shall have 8 electrically separate contacts field adjustable from normally open (N/O) to normally closed (N/C) or reverse. Limit switches shall be rated 10 ampere, 120 volt A.C.

2.2.5 Position Transmitter

A potentiometer displacement transducer and transmitter shall be furnished by the valve operator manufacturer which provides a precise electrical signal proportional to valve position. Output shall be a 4 to 20 mA signal with provisions for connection to the position indicating device to be installed in the gate room as well as control room. The position indicators shall be supplied and installed by the Contractor as required in SECTION 16051: CONTROL SYSTEM - LOW FLOW OUTLET THROTTLING AND SHUT-OFF VALVES.

2.2.6 Heaters

Strip-type heaters for operation on 120 volts A.C. shall be rated for 240 volts A.C. and shall be provided in the actuator housing. Heaters shall be sized to maintain the respective equipment's temperature 10 degrees F above ambient temperature.

2.2.7 Pushbutton Control Station

The pushbutton control station shall be furnished for direct mounting to the electric actuator. Three double "O" ring sealed pushbuttons labeled "OPEN", "CLOSED", "STOP", one selector switch labeled "LOCAL", "OFF", "REMOTE", and two indicating lamps, RED for open and GREEN for closed, shall be furnished for the pushbutton control station. A power on LED pilot light shall also be furnished on the actuator. The pushbutton station shall be suitable for weatherproof, explosion-proof, and submersible service and shall conform to the following:

1. Weatherproof - NEMA 1, 2, 3, 4, 6 and 12.

2. Explosion-proof - Certified by Factory Mutual for Class 1, Groups B, C, and D, Divisions 1 and 2.

3. Dust Ignition Proof - Class II, Groups E, F, Divisions 1 and 2.

4. Submersible - Suitable for 150-foot head of water for 24 hours.

Indicating lamps shall be high intensity LED type. The selector switch shall have a minimum of two electrical separate contacts for each position. The pushbutton and selector switch contacts shall be rated for 120-volt, 50/60 Hertz, single-phase, 10 amperes continuous current.

2.2.8 Mechanical Position Indicator

A mechanical position indicator shall be furnished. The mechanical indicator shall be an easily readable pointer dial calibrated from 0 to 100 percent corresponding to 0 to 100 percent valve position. Electronic or electrical indication for this dial is not acceptable.

2.2.9 Torque Switch

Each valve actuator shall be equipped with a switch that will interrupt the control circuit in both the opening and closing directions when valve torque overload occurs or when valves require torque switch setting in the closed or open position. The torque switch shall have graduated dials for both open and close directions of travel and each shall be independently adjustable, with a positive means to limit the adjustability so as to not exceed the actuator output torque capability. Mechanical torque springs for load control shall be field replaceable without need of actuator dismantling or removal of the worm assembly.

2.3 GASKETS AND HARDWARE

2.3.1 General

All nuts, bolts, washers, gaskets and other hardware required for installation of the valves, pipe spools and accessories shall be furnished with the valves. Hardware shall be in accordance with ASTM A 307, Grade B or ASTM A 193, Grade B7, hot-dipped galvanized after fabrication. Gaskets shall be 1/8-inch cloth inserted rubber, full face.

2.3.2 Knife Gate

All nuts, bolts and washers used for the fabrication of the valve and bonnet shall be corrosion resistant steel in accordance with ASTM A 193, Grade B8(Type 304 or 316).

PART 3 EXECUTION

3.1 WELDING

All welding used in manufacturing the valves shall be performed in accordance with SECTION 05501: METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS. Prior to heat treating, any defects in welds shall be repaired and re-examined. After all welding has been completed and prior to any machining, the complete welded valve body with the fixed cone and the complete welded cylinder gate shall be heat treated by heating the entire unit in a furnace in accordance with SECTION 05501: METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS. Localized stress relieving shall not be permitted. All welds shall be 100 percent magnetic-particle inspected after heat treating and after the final grinding or machining. If magnetic-particle inspection is not feasible for any welds, then those welds shall be liquid-penetrant inspected. These tests shall ensure that all welds are free from surface discontinuities and cracks. Repairs shall be made as required until all welds pass inspection.

3.2 THREADS

3.2.1 Pipe Threads

The thread dimensions of all piping shall be in accordance with ANSI B2.1 for "Pipe Thread (Except Dryseal)".

3.2.2 Other Threads

All bolts, stud machine screws, cap screws, nuts, and tapped holes shall be threaded in accordance with ANSI B1.1 for "Unified Inch Screw Threads".

3.3 PAINTING

After the equipment has been manufactured, all noncorrosion-resisting surfaces shall be painted with System No. 2 according to the requirements of specification SECTION 09940: PAINTING HYDRAULIC STRUCTURES AND APPURTENANT WORKS. All painted surfaces shall be protected from abrasion or other damage at all times.

3.4 SUPPLIER'S NAMEPLATE

A brass nameplate shall be securely attached giving the supplier's name, address, date, weight of valve, and other pertinent data on the downstream face of each valve at a location where it can be easily read.

3.5 TOOLS

One set of any special tools required for assembly or disassembly of any of the equipment being supplied shall be furnished on an approved tool board. The bidder shall submit a list of such tools to be furnished along with the bid.

3.6 SPARE PARTS

All spare parts shall be duplicates of the original parts they are intended to replace. Each spare part shall bear a tag or label securely attached clearly identifying the component for which it is intended. The following spare parts shall be furnished:

Quantity	Item
1 set, each	Valve packings, gaskets, bushings, seals
1 set, each	Seat rings
1, each type	Torque switch
2, each type	Limit switch
1, each type	Position transmitter/transducer
2, each type	Grease fitting

3.7 SERVICES OF ERECTING ENGINEERS

The valve supplier shall be required to provide one or more competent erecting engineers who shall supervise and be responsible for the correctness of the Contractor's assembly procedures, method of alignment, installation of equipment, and testing. When requested, the erecting engineer shall also supervise and be responsible for initial starting and all subsequent operation of the equipment until the field tests are completed. The erecting engineer shall instruct the Contracting Officer,

for a minimum of one full day, in the operation and maintenance features of the work. The services of the erecting engineers shall be furnished at no extra cost to the Government for such reasonable time as determined necessary by the Contracting Officer. The erecting engineers shall, throughout the installation and testing of the valves, comply with all accident prevention procedures as directed.

3.8 ELECTRICAL EQUIPMENT

All electrical devices shall be installed as part of the valves installation in accordance with the applicable provisions of SECTION 16415: ELECTRICAL WORK, INTERIOR and as shown on the specification drawings and manufacturers' approved shop drawings.

3.9 ACCEPTANCE TESTING

3.9.1 Motor Operators and Operating Mechanisms

After the equipment is installed, the Contractor shall test, initialize, calibrate, and checkout the valve and electric operator and all associated equipment furnished under this section. The testing shall verify proper alignment of the operator by operating the valve from fully open to fully closed positions. Position limit switches shall be adjusted and tested for proper operation. The pushbutton station shall be operated to verify proper operation of all pushbuttons, lamps, and mode switch. The valve position 4-20 ma output shall be tested for proper operation and shall be calibrated for 0 to 100 percent valve opening. A calibrated test set shall be used for monitoring the valve position current. The testing will be witnessed by the Contracting Officer's representative.

If the equipment furnished under the specifications is found to be malfunctioning and is not in working order, the contractor shall be responsible for the repair, realignment, rewiring, or replacement of equipment as may be required to restore the equipment to proper operation.

3.9.2 Valves

Prior to delivery, each valve shall undergo manufacturer's testing of valve operation with the operator installed and, in addition, after installation, a hydrostatic pressure of 150 feet shall be applied to each of the valves in the closed position. The pressure shall be held for 15 minutes. No part of the valves shall be permanently deformed. The pressure shall then be lowered to 96 feet and held for 15 minutes. The rate of leakage from each valve shall not exceed 0.5 gallons per minute for a 30-minute period after water up is completed. Each valve shall be operated at least twenty cycles from fully opened to fully closed. During this test, each valve shall operate satisfactorily and there shall be no evidence of galling or wear at any friction point. Each operator and operating mechanism shall also operate satisfactorily without evidence of any defect. Each valve shall pass these tests before acceptance is given.

3.10 QUALITY ASSURANCE

In accordance with SC-30, the materials, installation and testing shall be inspected for compliance with the contract requirements.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15300

PIPING SYSTEMS - GENERAL

SECTION 15300

PIPING SYSTEMS - GENERAL

PART 1 GENERAL

1.1 GENERAL INFORMATION

This section covers all operations in connection with the installation of the mechanical piping systems.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Latest revisions and versions shall be used.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B2.1	(1990) Pipe Threads (Except Dry Seal)Specifications, Dimensions, and Gaging for Taper and Straight Pipe Threads
ANSI B16.5	(1988) Pipe Flanges and Flanged Fittings
ANSI B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.25	(1992) Buttwelding Ends
ANSI B31.1	(1995) Power Piping Addenda
ANSI Z49.1	(1994) Safety in Welding and Cutting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 182	(1995) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High- Temperature Service
ASTM A 276	(1998) Stainless Steel Bars and Shapes
ASTM A 312	(1995) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM F 104	(1995) Nonmetallic Gasket Materials

AMERICAN WATERWORKS ASSOCIATION (AWWA)

AWWA C203	(1997; addenda C203a - 1999) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C206	(1997) Field Welding of Steel Water Pipe
AWWA C207	(1994) Steel Pipe Flanges for Waterworks Service - Sizes 4 Inch through 144 Inch

FEDERAL SPECIFICATIONS (FS)

FS 0-F-506	Flux, Soldering, Paste and Liquid
FS T-0-56A	(1970) Oakum, Marine
FS FF-B-575C	(1970) Bolts, Hexagon and Square
FS FF-N-836E	(1994) Nut: Square, Hexagon, Cap, Slotted, Castle Knurled, Welding and Single Ball Seat
FS FF-S-85C	(1994) Screw, Cap, Spotted and Hexagon Head
FS FF-S-325	Shield Expansion; Nail, Expansion and Nail, Drive Screw (Devices, Anchoring, and Masonry)
FS HH-G-156E	(1993) Gasket Material, General Purposes, Rubber Sheets, Strips and Special Pieces
FS HH-P-46E	(1991) Packing, Asbestos, Sheet, Compressed
FS QQ-C-40	(1970) Caulking, Lead Wool and Lead Pig
FS QQ-S-571	Solder, Electronic
FS WW-T-799	Tube, Copper, Seamless, Water (for Use with Solder-Flared or Compression-Type Fittings)
FS WW-U-516	Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections
FS WW-U-531	Unions, Pipe, Steel or Malleable Iron: Threaded Connection, 150 lb., 250 lb., and 300 lb. WSP

MILITARY SPECIFICATIONS (MIL)

MIL-T-27730	(Rev. A) Tape, Antiseize, Polytetrafluoroethylene, with Dispenser

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be

submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Piping Systems; G.

The specification drawings show the layout of piping and other work of the piping systems. The Contractor shall carefully examine the specification drawings and shall provide detailed shop drawings. Any proposed departure from the layout details shown on the specification drawings which are necessitated by field conditions or other causes shall be submitted as shop drawings.

SD-03 Product Data

Materials and Equipment; G.

Within 60 days after award of the contract and before any materials or equipment are purchased a complete list of materials and equipment to be incorporated into the work shall be submitted. This list shall include the names and addresses of the manufacturers, the appropriate catalog cuts, their catalog numbers and trade names. The equipment list shall stipulate by drawing part numbers or by description where the items are to be used. Approval of the materials shall be based on the manufacturer's published ratings. Any materials and equipment listed which are not in accordance with the specification requirements shall be rejected.

SD-06 Test Reports

Special Quality Control for Pressure Sensing System; G

Before work is started on the pressure sensor piping, a construction sequence and quality control plan for the entire work shall be submitted. Typical items to be included in the submitted plan shall include:

1. Step-by-step construction sequence.

2. Color coding each section of tubing at a minimum of every 5 feet to assure and keep track of the sensor from each station. Each of the tubes shall have a specific color code which shall match the existing color code.

3. Method of soldering of copper tubing, and support for copper tubing during installation.

4. Method of keeping tubing free of water and debris during construction.

5. Bubble-testing with soap solution each tubing joint as specified in paragraph: INSTRUMENTATION PIPING before it is made inaccessible by further construction. Testing procedure shall include marking joints which have been tested and tagging defective joints.

6. Water pressure testing each line entirely as specified in Paragraph: PRESSURE TESTS.

7. A check-out system to assure that each step of work is approved by the Contracting Officer before proceeding.

8. Reporting each test and inspection result.

1.4 PIPING SYSTEMS

1.4.1 Work Included

The fittings, valves, equipment, and appurtenances needed to complete the systems listed below shall be furnished and installed by the Contractor:

1. Minimum Discharge Line Piping

2. Fill line for RO water conduits

3. Instrumentation Piping

1.4.2 Damage Repair

Damage to structures, piping, wiring, or equipment as a result of installation procedures shall be repaired by mechanics skilled in the trades involved.

1.4.3 Protection to Fixtures, Materials and Equipment

Pipe, valves, and equipment openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemical or mechanical injury. At the completion of all work, the fixtures, material and equipment shall be thoroughly cleaned. Any manufacturer's temporary protective coatings on the inside and outside of the pipes and tubes for the instrumentation piezometer piping system shall be removed by an approved method.

1.4.4 Handling of Pipe, Equipment and Materials

Prior to and during installation, the pipe, equipment, materials and accessories shall be handled in such a manner as to prevent injury in any way to these items or materials.

1.4.5 Workmanship

All runs of piping and outlets shall be installed as indicated on the specification drawings. All piping shall be installed as closely as possible to walls, ceilings, columns, and all other surfaces of the structure so as to occupy the minimum of space, and shall be run parallel with lines of the structure, unless otherwise distinctly shown or noted on the specification drawings. Pipe shall be cut accurately to measurements established at the structure by the Contractor, and shall be worked into place without springing or forcing. Proper allowance shall be made for expansion and contraction of the pipe, whether or not such provision is shown on the specification drawings. All valves, traps or other accessories of the systems which have to be operated or repaired in the normal operation or maintenance of the system shall be installed in an accessible place. The pipe alignment of the installations of various piping systems shall be such that there shall be no perceptible bends or kinks. The pipes shall be pitched in the direction of flow for each system or as indicated or specified. Misalignment shall be considered sufficient

cause for rejection, and rework of the piping sections involved shall be repaired. All equipment furnished under this section shall be installed in accordance with the manufacturer's recommendations.

1.5 WARRANTY

Manufacturer's warranties or guaranties shall be furnished, on all equipment supplied under this section that normally carry a warranty or guarantee. The period of the warranty shall be at least 1 year and shall start from the date of acceptance of the equipment either for beneficial use or final acceptance,whichever is earlier and shall be against defective materials, design and workmanship. Upon receipt of notice of failure of any part or parts, they shall be replaced promptly by the Contractor with new parts.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 General

Materials and equipment shall conform to the drawings and these specifications. Materials and equipment shall be the products of manufacturers regularly engaged in the manufacture of such products. Pressure ratings of valves and fittings specified or shown on the drawing material lists refer to class unless otherwise indicated. Materials and equipment differing in minor respects from that specified may be proposed, provided such differences are clearly stated. All like materials and equipment shall be by the same manufacturer. Any materials required which are not covered in the piping material schedule, on the specification drawings, or in these specifications shall conform to applicable Federal Specifications, grade or class as required; or the American Society for Testing Materials; or the American National Standards Institute; or American Water Works Association. In cases where material is not covered by one of the listed specification groups, the highest commercial grade of material of product available shall be furnished. Fittings, flanges, unions and valves shall be marked in accordance with a standard practice of identification of valves, fittings, flanges and unions, such as the "MSS Marking System No. SP-25". Particular attention shall be given to the marking of valves to indicate body and trim material and pressure rating.

2.1.2 Bolts, Nuts, and Studs

2.1.2.1 General

Unless otherwise indicated, threaded bolts, nuts, and studs shall conform to the requirements of FS FF-B-575C, type III, Grade 1. Threaded nuts for general bolting, unless otherwise indicated, shall conform to FS FF-N-836E, type II Style 11, Grade 1.

2.1.2.2 Corrosion-Resisting Steel for Fasteners

Corrosion-resisting steel for capscrews, bolts, and nuts shall be as called for on the drawings or shall conform to ASTM A 276. Lock washers specified as corrosion resisting steel shall be corrosion-resisting steel of good commercial grade.

2.1.2.3 Capscrews

Unless otherwise indicated or specified, cap screws shall conform to the requirement of FS FF-S-85C, type, style, and grade as required.

2.1.2.4 Anchor Bolts

Anchor bolts shall be in accordance with SECTION 05120: STRUCTURAL STEEL AND MISCELLANEOUS METAL.

2.1.2.5 Concrete Anchors

Concrete anchors for piping work shall conform to the requirements of FS FF-S-325, Group II, Type 4; Group III, Type 1; or Group VIII, Type 1 or 2. The anchors shall be sized for the nominal bolt size of the device being attached or suspended. Where the attached or suspended equipment does not bear directly on the concrete, an OG washer or heavy steel or malleable-iron washer and nut shall be used to provide a constant loading on the anchor. Safe working loads shall be computed at 25 percent of the proof load test.

2.1.3 Pipe Joint Material

2.1.3.1 Caulking Lead

Lead shall meet the requirements of FS QQ-C-40, Type I, Grade AA.

2.1.3.2 Neoprene Gaskets

Neoprene gaskets for cast-iron soil pipe shall meet the applicable requirements of ASTM C 564 and shall be a double seal, molded compression type.

2.1.3.3 Oakum

Oakum shall meet the requirements of FS T-0-56A, class as required.

2.1.3.4 Tape for Threaded Pipe Joints

Tape shall meet the requirements of MIL-T-27730.

2.1.4 Gaskets

Gasket material shall meet the requirements of the following listed specifications as applicable; FS HH-P-46E, or ASTM F 104 (Material Identification P-1161A).

2.1.5 Rubber Sheet Gaskets

Rubber sheet for use as gaskets shall meet the requirements of FS HH-G-156E, except as otherwise provided.

2.1.6 Pipe and Fittings

2.1.6.1 Low flow outlet piping, including drain pipe.

The pipe shall be a minimum thickness of 3/8-inch ASTM A 53 steel. All internal surfaces, exposed (not embedded) surfaces and the first 3 feet of external surfaces of embedded pipe entering any concrete structure shall be painted with coal-tar enamel as per AWWA C203.

2.1.6.2 Conduit Fill Lines

The R.O. conduit fill pipe shall be 4-inch Schedule 40 Stainless Steel conforming to the requirements of ASTM A 312, Grade TP 304. Schedule 40S and pipe fittings shall be of stainless steel ASTM A 182, Grade F 304, 150 pound class.

The low flow outlet fill pipe shall be 3-inch Schedule 40 Stainless Steel conforming to the requirements of ASTM A 312 Grade TP 304, Schedule 40S and pipe fitting shall be of stainless steel ASTM A 182, Grade F304, 150 pound class.

2.1.6.3 Instrumentation Piping

The copper piping shall be Type K hard drawn, solder joint, conforming to FS WW-T-799.

2.1.6.4 Welded Steel Fittings

Flanges shall be 300 psi forged steel, slip-on when used on pipe and welding neck when used on fittings. Pipe flanges larger than 24-inch shall be AWWA class E meeting AWWA C207 standards. Pipe flanges smaller than 24-inch shall be ANSI B16.5.

2.1.6.5 Copper Pipe Fittings

Wrought copper, solder joint ANSI B16.22 or cast brass solder-joint ANSI B16.18.

2.1.7 Unions

FS WW-U-516, or FS WW-U-531, as applicable. Unions in copper and brass lines shall be bronze.

2.1.8 Solder

FS QQ-S-571, Composition Sn5O (or Sb5-- to be used where designated). Flux shall conform to FS 0-F-506.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPING

3.1.1 General

The installation of all piping, valves, fittings, and related accessories shall be made as shown and specified. Prior to installation, all pipe, valves, and fittings shall be clean. Care shall be exercised not to damage the pipe, valves, fittings or any accessories during installation. For installation of instrumentation piping see paragraph: INSTRUMENTATION PIPING.

3.1.2 Coordination with Other Work

The piping covered by this section shall be installed in coordination with all other work so that all piping is installed in the most direct and workmanlike manner, and so that interferences between piping, ducts, equipment, architectural and structural features shall be avoided if possible. In case interferences do develop, the Contracting Officer shall

decide which work shall be relocated regardless of which work was first installed. The structure shall not be cut or weakened when installing the piping and equipment.

3.1.3 Pipe Joints

3.1.3.1 General

Drawings show the minimum pipe joints required. Additional joints may be provided as necessary to fabricate and install pipe or to facilitate galvanizing pipe after fabrication. Unions or flanged connections shall be provided in all steel lines downstream of valves, and so located that the valves or equipment can be removed for repair or replacement without removing an excessive amount of piping. Pipe joints in steel pipe, 2-1/2 inches and smaller in diameter shall be made with threaded pipe, fittings and valves unless shown otherwise. Pipe joints in steel pipe 3 inches and larger shall be welded, flanged or grooved type.

3.1.3.2 Threaded Joints

Threaded joints shall conform to ANSI B2.1. Screwed joints shall be made with lubrication applied on the male threads only. Screwed joints shall be made metal to metal, and caulking of screwed joints to stop or prevent leakage shall not be permitted. Joints for water lines shall be lubricated with graphite in linseed oil, Teflon tape, oil, or other approved compound. The exposed threads on ferrous pipe shall be coated with zinc rich paint after assembly.

3.1.3.3 Flanged Joints

Flanges shall be of forged steel and 300 pound class unless otherwise specified or indicated. Slip-on flanges shall be used on pipe and welding neck flanges used with fittings. When steel flanges are to be bolted to cast iron valves or equipment having cast iron flanges, the 1/16-inch raised face on the steel flanges shall be removed. Joints shall be made up tight using 1/16-inch thick composition gaskets. Gaskets shall be the ring type for raised face flanges and full faced for flat faced flanges. Steel bolts shall be used for bolting flanged joints.

3.1.3.4 Welded Joints

Joints shall be made by qualified welders and shall meet the requirements of AWWA C206 and applicable requirements of ANSI B31.1. Welders and welding procedures shall be qualified in accordance with the requirements of ANSI B31.1 and AWWA C206. Welding shall be in accordance with provisions of ANSI Z49.1. Butt welding joints shall have pipe and fitting ends prepared in accordance with ANSI B16.25 and shall have a root weld no larger than 5/32-inch. Welding fitting wall thickness shall be equal to or thicker than the pipe wall thickness. Mitered joints shall be used only when shown on the specification drawings. Welded joints in galvanized lines shall be hot-dipped galvanized after fabrication except that field welded joints in galvanized lines, when specifically approved, shall be coated with zinc rich paint or galvanizing repair compound.

3.1.3.5 Solder Joints

Solder joints in copper tubing shall be soldered using 50-50 solder and petrolatum type flux. Solder joints shall have the ends of the pipe cut square with all burrs removed and the end of the pipe thoroughly cleaned on

the outside with emery or steel wool for a distance equal to the depth of the fitting socket. Tubing shall be clean and bright with no dark spots. The fitting socket shall likewise be thoroughly cleaned. The tubing shall be firmly seated in the fitting socket which shall be rotated several times to insure an even distribution of the flux. In cold weather the fitting shall be warmed with a torch to between approximately 70 and 80 degrees F. The fitting shall then be evenly heated with a torch and solder fed into the joint until it appears around the end of the fitting at the tubing circumference. Care shall be taken to prevent annealing of the tube and fittings when making connections.

3.1.3.6 Dielectric Connections

Connections between ferrous and nonferrous metallic pipe and equipment in water and air lines shall be made with dielectric unions or flanges. Piping entering or leaving the structure shall have a dielectric connection inside the building.

3.1.4 Embedded Pipe

Pipe to be embedded in concrete shall be located to line and grade and shall be braced securely to avoid displacement during the placement of concrete. During progress of the work all pipe to be embedded in any one pour shall be connected to previously embedded pipe or securely capped or plugged with solid wooden or metallic closures prior to starting the pour. Caps of plugs shall not be laced until all runs of piping affected are free and clear of internal obstructions. No cap or plug shall be removed without approval. Failure to observe these instructions shall result in the Contractor required to perform a complete flow test to demonstrate that the runs involved are free from obstructions. Embedded piping shall not be used for disposal of concrete curing water or other construction drainage.

3.1.5 Mechanical Joints/Couplings and Wrappings

The mechanical joints/couplings shall be Dresser Style 38 or approved equal. The burlap wrap shall be supported by sheet metal to assure an unobstructed void between couplings and between the pipe and burlap wrap.

3.1.6 Concrete Anchors

Concrete anchors shall be installed in accordance with the recommendations of the manufacturer.

3.2 INSTRUMENTATION PIPING

3.2.1 General

The water pressure sensing system will be used to monitor the water pressure in the regulating outlet conduit at various locations. The pressure data will be used to control the operation of the outlet works. The water pressure sensing system draws water through 1/4-inch diameter holes in surface mounted plates located in the wet well and the RO conduit. The water is transported through a system of pipes to the RO gate structure, where the pressure is measured with specified instrumentation. The pressure data shall then be transferred through telemetry to a remote location.

3.3 OUTLET CONDUIT FILL LINES

The RO and low flow conduit fill lines shall be furnished, installed and capped as required in SECTION 15301: FILLING SYSTEMS FOR REGULATING AND LOW FLOW OUTLETS.

3.4 PRESSURE TESTS

3.4.1 General

The tests shall be made with blank flanges or with suitable caps on ends of the pipe sections to be tested. The piping tests shall be conducted before the equipment has been connected to the piping. All sections of the piping specified herein shall be tested and approved before acceptance. Any defects or leaks disclosed by tests shall be repaired and retested. The Contracting Officer shall be notified in sufficient time before starting any test to permit them to witness the test. Each welded joint shall be hammered while under test pressure. All piping shall be tested at the pressure shown in the following table for a length of time necessary to determine tightness but in no case less than one hour. A drop in pressure of more than 5 percent during the test period will be considered failure and subsequent repairs and retesting will be required.

3.4.2 Test Pressure and Mediums

The test pressure and mediums are shown in the table for the following categories of piping:

TEST PRESSURES AND MEDIUMS

	Test Pressure (psig)	Test Media
1. Water Conduit Filling Line	250	Water
2. Low Flow Outlet Pipes	250	Water
3. Water Pressure Sensor Piping	250	Water

3.5 PAINTING

All painting under this section shall conform to the provisions of SECTION 09940: PAINTING HYDRAULIC STRUCTURES AND APPURTENANT WORKS.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15301

FILLING SYSTEMS FOR REGULATING AND LOW FLOW OUTLETS

-- End of Section Table of Contents --

SECTION 15301

FILLING SYSTEMS FOR REGULATING AND LOW FLOW OUTLETS

PART 1 GENERAL

1.1 GENERAL INFORMATION

1.1.1 Filling System for Regulating Outlets

The Contractor shall design, detail, furnish, install and test six (6) sets of 4-inch filling systems complete with fittings, flanges, elbows, valves and accessories for the Regulating Outlets as shown on the specification drawings or as directed. Each filling system will be used to fill water in the Regulating Outlet between the emergency closure gate and the Regulating Outlet Slide Gate, to obtain balanced water pressures upstream and downstream of the emergency closure gate prior to opening of the closure gate, after maintenance operations on the downstream Regulating Slide Gates. The pipes shall be provided with standard T's downstream of the gate valves to make interconnections using hoses if so needed.

1.1.2 Filling System for Low Flow Outlets

The Contractor shall design, detail, furnish, install and test two (2) sets of 3-inch filling pipes complete with fittings, flanges, elbows, valves and accessories as shown on the specification drawings or as directed. Each filling pipe will be used to fill the Low Flow Outlet Pipe between the maintenance bulkhead and the knife gate throttling valve so as to obtain balanced water pressure upstream and downstream of the maintenance bulkhead prior to opening of the bulkhead after maintenance operations of the butterfly shut off valve and the knife gate throttling valve.

1.1.3 Filling System Piping

The filling system pipes, fittings, valves and accessories shall conform to ANSI 150 pound class. They shall be designed and detailed to withstand a static pressure of 100 psi and shall be bubble tight.

1.1.4 Filling System Gate Valves

The gate valves shall be designed to operate under a minimum unbalanced pressure of 100 psi by manual operation.

1.2 REFERENCES

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 312	(1995) Seamless and Welded Austenitic Stainless Steel Pipes

1.3 SUBMITTALS

See SECTION 15300 - PIPING SYSTEMS - GENERAL.

PART 2 PRODUCTS

2.1 FILLING PIPES

The filling pipes shall be of stainless steel conforming to ASTM A 312, Type 316, Schedule 40S. All joints and fittings shall be made with Type 316 stainless steel gasketed flanges conforming to ANSI 150 pound class or shall be full penetration stainless steel welded.

2.2 GATE VALVES

The gate valves shall be 125 pound stainless steel wedge gate valves, with stainless steel body and bronze trim.

2.3 PIPE FITTINGS, FLANGES, AND ELBOWS

All fittings, flanges and elbows for the filling pipe systems shall be Type 316 stainless steel conforming to ANSI 150 pound class. They shall be designed to be bubbletight and be capable of withstanding 50 psi internal design pressure when fully assembled and a test pressure of 75 psi for 15 minutes.

PART 3 EXECUTION

See PART 3 - EXECUTION of SECTION 15300, PIPING SYSTEMS - GENERAL.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15400

PLUMBING, GENERAL PURPOSE

-- End of Section Table of Contents --

SECTION 15400

PLUMBING, GENERAL PURPOSE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22	(1986; Z21.22a) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM A 47	(1999) Ferritic Malleable Iron Castings
ASTM A 53	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM A 105	(1998) Carbon Steel Forgings for Piping Applications
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 193	(2000) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 515	(1989; R 1997) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516	(1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 536	(1999e1) Ductile Iron Castings
ASTM A 615	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 888	(1998e1) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain,

	Waste, and Vent Piping Applications
ASTM B 32	(1996) Solder Metal
ASTM B 42	(1998) Seamless Copper Pipe, Standard Sizes
ASTM B 43	(1998) Seamless Red Brass Pipe, Standard Sizes
ASTM B 75	(1999) Seamless Copper Tube
ASTM B 152	(1997a) Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B 306	(1999) Copper Drainage Tube (DWV)
ASTM C 309	(1995) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM B 370	(1998) Copper Sheet and Strip for Building Construction
ASTM B 584	(1998a) Copper Alloy Sand Castings for General Applications
ASTM B 813	(2000) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(1999) Rubber Products in Automotive Applications
ASTM D 2235	(1996a) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2239	(1999) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D 2241	(1999a) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2447	(1999) Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
ASTM D 2464	(1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1999) Poly(Vinyl Chloride) (PVC) Plastic

	Pipe Fittings, Schedule 40
ASTM D 2467	(1999) Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(1997) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2661	(1997ael) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2665	(1998) Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	(1996a) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2683	(1998) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 2737	(1999) Polyethylene (PE) Plastic Tubing
ASTM D 2751	(1996a) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 2822	(1991; R 1997el) Asphalt Roof Cement
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3034	(1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3035	(1995) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3122	(1995) Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings
ASTM D 3138	(1995) Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3261	(1997) Butt Heat Fusion Polyethylene (PE)

	Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3308	(1997) PTFE Resin-Skived Tape
ASTM D 3311	(1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM E 1	(1998) ASTM Thermometers
ASTM F 409	(1999a) Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
ASTM F 437	(1999) Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 438	(1999) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F 439	(1999) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441	(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 442	(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 493	(1997) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F 628	(1999el) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core
ASTM F 891	(1998el) Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core
ASTM F 1290	(1998a) Electrofusion Joining Polyolefin Pipe and Fittings

ASME INTERNATIONAL (ASME)

ASME A112.6.1M	(1997) Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.19.1M	(1994; R 1999) Enameled Cast Iron Plumbing Fixtures
ASME A112.19.2M	(1998) Vitreous China Plumbing Fixtures

ASME A112.21.2M	(1983) Roof Drains
ASME A112.36.2M	(1991; R 1998) Cleanouts
ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.4	(1998) Gray Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.12	(1998) Cast Iron Threaded Drainage Fittings
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(1992; Errata Jan 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(1991; R 1998) Cast Copper Alloy Pipe Flanges, Class 150, 300, 400, 600, 900, 1500, and 2500, and Flanged Fittings, Class 150 and 300
ASME B16.29	(1994) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1998) Power Piping
ASME B31.5	(1992; B31.5a1994) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(1995) Water Pressure Reducing Valves for Domestic Water Supply Systems
ASSE 1018	(1986) Trap Seal Primer Valves Water Supply Fed

ASSE 1037	(1990; Rev thru Mar 1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA EWW	(1999) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1999) Hypochlorites
AWWA B301	(1992; Addenda B301a - 1999) Liquid Chlorine
AWWA C105	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C203	(1997; addenda C203a - 1999) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA C700	(1995) Cold-Water Meters - Displacement Type, Bronze Main Case
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS B2.2	(1991) Brazing Procedure and Performance Qualification

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(1997) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI HSN-85	(1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

PL 93-523	(1974; Amended 1986) Safe Drinking Water Act

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA Tube Handbook	(1995) Copper Tube Handbook

FEDERAL SPECIFICATIONS (FS)

FS QQ-B-654 (Rev A; Am 1; Notice 1) Brazing Alloys, Silver

FS WW-V-35 (Rev C) Valve, Ball

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANCIAL OFFICIALS (IAPMO)

IAPMO Z124.5 (1997) Plastic Toilet (Water Closets) Seats

INTERNATIONAL CODE COUNCIL (ICC)

CABO A117.1 (1998) Accessible and Usable Buildings and Facilities

ICC Plumbing Code (2000) International Plumbing Code (IPC)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25 (1998) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-67 (1995) Butterfly Valves

MSS SP-69 (1996) Pipe Hangers and Supports - Selection and Application

MSS SP-70 (1998) Cast Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71 (1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends

MSS SP-72 (1999) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-73 (1991; R 1996) Brazing Joints for Copper and Copper Alloy Pressure Fittings

MSS SP-78 (1998) Cast Iron Plug Valves, Flanged and Threaded Ends

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

MSS SP-85 (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

PLUMBING-HEATING-COOLING CONTRACTORS NATIONAL ASSOCIATION (NAPHCC)

NAPHCC Plumbing Code (1996) National Standard Plumbing Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (1999) Installation of Air Conditioning

and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 14	(1999) Plastics Piping Components and Related Materials
NSF 61	(1999) Drinking Water System Components - Health Effects (Sections 1-9)

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA-01	(1999) Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(1992) Water Hammer Arresters

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J 1508	(1997) Hose Clamps

1.2 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

1.3 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Plumbing System

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system

including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

Electrical Schematics

Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device.

SD-03 Product Data

Welding

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Vibration-Absorbing Features

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

Plumbing System

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

SD-06 Test Reports

Tests, Flushing and Disinfection

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-07 Certificates

Materials and Equipment

Where materials or equipment are specified to comply with requirements of AGA, ASME, or NSF proof of such compliance shall be included. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

SD-10 Operation and Maintenance Data

Plumbing System; G.

Six copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

1.5 REGULATORY REQUIREMENTS

Plumbing work shall be in accordance with ICC Plumbing Code.

1.6 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

PART 2 PRODUCTS

2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used under ground. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: ASTM A 74, AWWA C606.

b. Coupling for Steel Pipe: AWWA C606.

c. Couplings for Grooved Pipe: Malleable Iron ASTM A 47, Grade 32510.

d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

e. Neoprene Gaskets for Hub and Cast-Iron Pipe and Fittings: CISPI HSN-85.

f. Brazing Material: Brazing material shall conform to AWS A5.8, BCuP-5.

g. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides. Silver brazing materials shall be in accordance with FS QQ-B-654.

h. Solder Material: Solder metal shall conform to ASTM B 32.

i. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.

j. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe, ASTM D 3308.

k. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C 564.

l. Rubber Gaskets for Grooved Pipe: ASTM D 2000, maximum temperature 230 degrees F.

m. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.

n. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A 183.

o. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D 3138.

p. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D 2235.

q. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.

r. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F 493.

s. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105. Blind flange material shall conform to ASTM A 516 cold service and ASTM A 515 for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193.

t. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D 3122.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201.

b. Copper, Sheet and Strip for Building Construction: ASTM B 370.

c. Asphalt Roof Cement: ASTM D 2822.

d. Hose Clamps: SAE J 1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines:

AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Polyethylene Encasement for Ductile-Iron Piping: AWWA C105.

l. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.1.

m. Thermometers: ASTM E 1.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67

Description	Standard
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves	FS WW-V-35
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Vacuum Relief Valves	ANSI Z21.22
Water Pressure Reducing Valves	ASSE 1003
Trap Seal Primer Valves	ASSE 1018

2.3.1 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be detachable.

2.3.2 Yard Hydrants

Yard box or post hydrants shall have valve housings located below frost lines. Water from the casing shall be drained after valve is shut off. Hydrant shall be bronze with cast-iron box or casing guard. "T" handle key shall be provided.

2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with NAPHCC Plumbing Code. Fixtures for use by the physically handicapped shall be in accordance with CABO A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts

of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature. Plumbing fixtures shall be as indicated in paragraph: PLUMBING FIXTURE SCHEDULE.

2.4.1 Lavatories

Enameled cast-iron lavatories shall be provided with two cast-iron or steel brackets secured to the underside of the apron and drilled for bolting to the wall in a manner similar to the hanger plate. Exposed brackets shall be porcelain enameled.

2.4.2 Automatic Flushing System

Flushing devices shall be provided as described in paragraph: FIXTURES AND FIXTURE TRIMMINGS.

2.5 DRAINS

2.5.1 Trench Drains

Presloped trench drainage system. Glass-filled polyester fiberglass drain channel with 0.75 percent bottom slope. All sections modular 10 feet lengths with interlocking ends. Complete with heavy-duty, Dura-coated steel frame at surface, combination anchor tabs/leveling devices at appropriate locations and heavy-duty cast iron grate.

2.5.2 Roof Drains and Expansion Joints

Roof drains shall conform to ASME A112.21.2M, with dome and integral flange, and shall have a device for making a watertight connection between roofing and flashing. The whole assembly shall be galvanized heavy pattern cast iron. For aggregate surface roofing, the drain shall be provided with a gravel stop. On roofs other than concrete construction, roof drains shall be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided when required to suit the building construction. Strainer openings shall have a combined area equal to twice that of the drain outlet. The outlet shall be equipped to make a proper connection to threaded pipe of the same size as the downspout. An expansion joint of proper size to receive the conductor pipe shall be provided. The expansion joint shall consist of a heavy cast-iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve shall have a nominal thickness of not less than 0.134 inch. Gaskets and packing shall be close-cell neoprene, O-ring packing shall be close-cell neoprene of 70 durometer. Packing shall be held in place by a packing gland secured with bolts.

2.6 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not

less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.7 SEPTIC TANK

Septic tank shall be of size indicated and shall be cast in rigid form. Manufacture tank in such manner to have monolithic construction from base to minimum height of 2 inches above static water level. Septic tank shall be listed and approved by International Association of Plumbing and Mechanical Officials (IAPMO). Tank body shall be of semi-cylindrical shape.

Septic tank shall be precast of concrete with minimum compressive strength of 3,000 psi at 28 days, using type II portland cement. Reinforcing bar shall be ASTM A 615 Grade 40.

Design septic tank capable of withstanding normal earth loads and pressures put upon it. Septic tank cap shall be capable of supporting earth loads of not less than 300 pounds per square foot when maximum coverage does not exceed 3 feet. Septic tank shall be 2 compartment being minimum of 2/3 of total liquid capacity.

Septic tank shall have minimum of 2 manholes with dimension of not less than 20 inches. Fitting shall be made of ABS plastic, vitrified clay, or cast iron soil pipe. Cast-in-place fittings shall not be acceptable. Protect septic tank from corrosion by coating entire exterior and interior with bituminous coating. Coating shall consist of combination of air-blown and steam-blown asphalts, and shall conform to following specifications: ASTM C 309 Type IV, ASTM D 41, and FHA requirements.

2.8 LEACH LINE

2.8.1 PVC Fittings

Socket type, solvent welded, Schedule 80.

Perforated plastic pipe:

a. Acrylonitrile-Butadiene-Styrene (ABS) pipe: ASTM D 2751, with maximum SDR of 35.

b. Polyvinyl chloride (PVC) pipe: ASTM D 3034, with maximum SDR of 35 and with flexible elastomeric seal joints.

c. Perforations: Perforations in ABS and PVC pipe shall be circular, not more than 5/16 inch or less than 3/16 inch in diameter, and

arranged in rows parallel to longitudinal axis of pipe. Perforations shall be approximately 3 inches on center along rows. Rows shall be approximately 1-1/2 inches apart and arranged in staggered patten so perforations lie at mid-point between perforations in adjacent rows. Space rows over not more than 90 degrees of circumference. Spigot or tongue end of pipe shall be unperforated for length equal to depth of socket; continue perforations at uniform spacing over entire length of pipe.

d. Join ABS pipe using solvent cement or elastomeric joints in accordance with ASTM D 2751

e. Join PVC pipe in accordance with ASTM D 3212

f. Test drain lines with water and 2 inches diameter cork before covering. Cork shall flow freely, within lines, from test point to test point. Remove obstructions and repeat test until system is satisfactory. Retest system again after backfill is placed. Portions of lines which restrict flow shall be repaired or removed and replaced, as directed, until entire system is satisfactory.

g. Protection from exposure to sun: Prior to and during installation, do not expose plastic pipe to direct sunlight for more than 14 days.

2.9 WATER HEATERS

2.9.1 Instantaneous Water Heater

Instant-Flow Water Heater: Electric heating coils and control components with cast aluminum casing and plastic housing with stainless steel parts.

Built-in power Switch: Turn on heating coil when hot water is being used and off when hot water is turned off.

Heater: White finish with required fittings and piping and electrical power connecting cable.

Provide separate shutoff valve on heater inlet water supply.

2.10 PUMPS

2.10.1 Sump Pumps

Sump pumps shall be of capacities indicated. The pumps shall be of the automatic, electric motor-driven, submerged type. Motors shall be totally enclosed. The suction side of each pump shall have a strainer of ample capacity. A float switch assembly shall start and stop each motor at predetermined water levels.

Power Cord: Single phase 50 feet long oil and water resistant with integrally grounded 3-prong plug. UL listed and with stainless steel cord connector.

Hose: 100 percent synthetic jacket with polyester lining. Ozone proof and mildew proof. Light weight 50 feet long.

2.11 WATER SERVICE METER

Cold water meter shall be of the positive displacement type conforming to AWWA C700. Meter register may be round or straight reading type, as provided by the local utility. Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Neither hubless cast-iron nor plastic pipe shall be installed under concrete floor slabs. Piping located in air plenums shall conform to NFPA 90A requirements. Unprotected plastic pipe shall not be installed in air plenums. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A gate valve or ball valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the finish grade or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body. Each outlet on the non-potable water line which may be used for drinking or domestic purposes shall be posted: "DANGER - UNSAFE WATER".

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and ball valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to PDI WH 201. Vertical capped pipe columns will not be permitted.

3.1.2 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.2.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.2.2 Mechanical Couplings

Grooved mechanical joints shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of the pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

3.1.2.3 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.2.4 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.2.5 Copper Tube and Pipe

The tube or fittings shall not be annealed when making connections. Connections shall be made with a multiflame torch.

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA Tube Handbook with flux and are acceptable for line sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA Tube Handbook.

c. Copper Tube Extracted Joint. An extracted mechanical joint may be

made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. Branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed in accordance with NAPHCC Plumbing Code using B-cup series filler metal in accordance with MSS SP-73. Soldered extracted joints will not be permitted.

3.1.2.6 Plastic Pipe

Acrylonitrile-Butadiene-Styrene (ABS) pipe shall have joints made with solvent cement. PVC and CPVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.2.7 Corrosive Waste Plastic Pipe

Joints for polyolefin pipe and fittings shall be made by mechanical joint or electrical fusion coil method in accordance with ASTM D 2657 and ASTM F 1290. Joints for filament-wound reinforced thermosetting resin pipe shall be made in accordance with manufacturer's instructions. Unions or flanges shall be used where required for disconnection and inspection.

3.1.2.8 Other Joint Methods

3.1.3 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.4 Corrosion Protection for Buried Pipe and Fittings

3.1.4.1 Steel

Steel pipe, joints, and fittings shall be cleaned, coated with primer, and wrapped with tape. Pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

3.1.5 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.5.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for cast-iron soil pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be

installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe and inside of sleeve or between jacket over insulation and sleeves. Sleeves in bearing walls shall be steel pipe or cast-iron pipe. Sleeves for membrane waterproof floors shall be steel pipe, cast-iron pipe, or plastic pipe. Membrane clamping devices shall be provided on pipe sleeves for waterproof floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. Plastic sleeves shall not be used in nonbearing fire walls, roofs, or floor/ceilings. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation. Pipes passing through sleeves in concrete floors over crawl spaces shall be sealed as specified above. The annular space between pipe and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant.

3.1.5.2 Flashing Requirements

Pipes passing through roof or floor waterproofing membrane shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter,

passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.5.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

3.1.5.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 6 inches in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.1.5.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs: Flashing Requirements and Waterproofing, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant.

3.1.6 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided.

3.1.7 Supports

3.1.7.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate

alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.7.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as shown. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

3.1.7.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 4 inches.

(2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.

(3) Have a high density insert for pipe 2 inches and larger and for smaller pipe sizes when the insulation is suspected of being visibly compressed, or distorted at or near the shield/insulation interface. High density inserts shall have a density of 8 pcf or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69

and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

(1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

(2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 4 inches and larger carrying medium less that 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.8 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be

removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.9 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron or plastic.

3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

3.2.1 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 39 inches above the floor. Bumpers for water closet seats shall be installed on the wall.

3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor.

3.3.4 Fixture Supports

Fixture supports for off-the-floor lavatories, water closets shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.4.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.3.4.2 Support for Cellular-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the cellular wall using through bolts and a back-up plate.

3.3.4.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.4.4 Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs

shall be fastened with not less than No. 10 wood screws, 1/4 inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

3.3.5 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 05501 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

3.3.6 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311. Traps for acid-resisting waste shall be of the same material as the pipe.

3.4 IDENTIFICATION SYSTEMS

3.4.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.4.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

3.5 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.6 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09900 PAINTING, GENERAL.

3.7 TESTS, FLUSHING AND DISINFECTION

3.7.1 Plumbing System

The plumbing system shall be tested in accordance with NAPHCC Plumbing Code.

3.7.2 Phenolic Resin Coatings

A certificate of compliance shall be submitted by the coating manufacturer that documents successful use of coating system under service conditions indicated on the drawings for a minimum of 2 years at three different locations, and that the coating material and application comply with the testing procedures outlined.

3.7.3 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.7.4 System Flushing

After tests are completed, potable water piping shall be flushed. In general, sufficient water shall be used to produce a minimum water velocity of 2.5 feet per second through piping being flushed. Flushing shall be continued until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced in line. After flushing and cleaning, systems shall be prepared for service by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the work is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation.

3.7.5 Operational Test

Upon completion of and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

f. Temperature of each domestic hot-water supply.

g. Operation of each roof drain by flooding with water.

h. Operation of each vacuum breaker.

3.7.6 Disinfection

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be

thoroughly flushed with water of sufficient velocity until all entrained dirt and other foreign material have been removed, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being disinfected shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. The system including the tanks shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.8 PLUMBING FIXTURE SCHEDULE

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, floor mounted. Floor flange shall be copper alloy, cast iron, or plastic.

Gasket shall be wax type.

Seat - IAPMO Z124.5, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 2-5/8 inches at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 1.6 gallons per flush.

P-5 LAVATORY:

Manufacturer's standard sink depth, enameled cast iron ASME A112.19.1M, ledge back.

Faucet - Faucets shall meet the requirements of NSF 61, Section 9. Faucets shall be single control, mixing type. Faucets shall have replaceable seats and washers. Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. Flow shall be limited to 2.5 gpm at a flowing pressure of 80 psi.

Handles - Crown type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel. See paragraph: FIXTURES for optional plastic accessories.

3.9 TABLES

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	B	C	D	E	F
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets	X	X	X	X	X	
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A 888	X	X	X	X		
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X		
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	X	
5	Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A 536 and ASTM A 47	X	X		X	X	
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47 for use with Item 5	X	X		X	X	
7	Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 5	X	X		X	X	
8	Wrought copper grooved joint pressure pressure fittings for non-ferrous pipe ASTM B 75 C12200, ASTM B 152, C11000, ASME B16.22 ASME B16.22 for use with Item 5	X	X				
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X	X	
10	Steel pipe, seamless galvanized, ASTM A 53, Type S, Grade B	X			X	X	
11	Seamless red brass pipe, ASTM B 43		X	X			
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X	

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE					
Item #	Pipe and Fitting Materials	A	B	C	D	E	F
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X	X	
14	Seamless copper pipe, ASTM B 42		X	X			
15	Cast bronze threaded fittings, ASME B16.15				X	X	
16	Copper drainage tube, (DWV), ASTM B 306	X*	X	X*	X	X	
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X	
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X	
19	Acrylonitrile-Butadiene-Styrene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D 2661, ASTM F 628	X	X	X	X	X	X
20	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D 2665, ASTM F 891, (Sch 40)	X	X	X	X	X	X
21	Not used.						
22	Not used.						
23	Not used.						
24	Not used.						

SERVICE:

A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent
E - Interior Rainwater Conductors Aboveground
F - Corrosive Waste And Vent Above And Belowground
* - Hard Temper

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE A	B	C	D
1	Malleable-iron threaded fittings, a. Galvanized, ASME B16.3 for use with Item 4a	X	X	X	X
	b. Same as "a" but not galvanized for use with Item 4b			X	
2	Grooved pipe couplings, ferrous pipe ASTM A 536 and ASTM A 47, non-ferrous pipe, ASTM A 536 and ASTM A 47,	X	X	X	
3	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47, for use with Item 2	X	X	X	
4	Steel pipe: a. Seamless, galvanized, ASTM A 53, Type S, Grade B	X	X	X	X
	b. Seamless, black, ASTM A 53, Type S, Grade B			X	
5	Not used.				
6	Not used.				
7	Not used.				
8	Not used.				
9	Not used.				
10	Cast bronze threaded fittings, ASME B16.15 for use with Items 7 and 8	X	X		X
11	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 7 and 8	X	X	X	X
12	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 7 and 8	X	X	X	X
13	Bronze and sand castings grooved joint pressure fittings for non-	X	X	X	

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE A	B	C	D
	ferrous pipe ASTM B 584, for use with Item 2				
14	Polyethylene (PE) plastic pipe, Schedules 40 and 80, based on outside diameter ASTM D 2447	X			X
15	Polyethylene (PE) plastic pipe (SDR-PR), based on controlled outside diameter, ASTM D 3035	X			X
16	Polyethylene (PE) plastic pipe (SIDR-PR), based on controlled inside diameter, ASTM D 2239	X			X
17	Butt fusion polyethylene (PE) plastic pipe fittings, ASTM D 3261 for use with Items 12, 13, and 16	X			X
18	Socket-type polyethylene fittings for outside diameter-controlled polyethylene pipe, ASTM D 2683 for use with Item 13	X			X
19	Polyethylene (PE) plastic tubing, ASTM D 2737	X			X
20	Chlorinated polyvinyl chloride (CPVC) plastic hot and cold water distribution system, ASTM D 2846	X	X		X
21	Chlorinated polyvinyl chloride (CPVC) plastic pipe, Schedule 40 and 80, ASTM F 441	X			X
22	Chlorinated polyvinyl chloride (CPVC) plastic pipe (SDR-PR) ASTM F 442	X			X
23	Threaded chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 80, ASTM F 437, for use with Items 20, and 21	X	X		X
24	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 40, ASTM F 438 for use with Item 23	X	X		X
25	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings Schedule 80, ASTM F 439 for use	X	X		X

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE A	B	C	D
	with Item 23				
26	Polyvinyl chloride (PVC) plastic pipe, Schedules 40, 80, and 120, ASTM D 1785	X			X
27	Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D 2241	X			X
28	Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D 2466	X			X
29	Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2467	X			X
30	Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2464	X			X
31	Joints for IPS pvs pipe using solvent cement, ASTM D 2672	X			X
32	Not used.				
33	Not used.				
34	Not used.				
35	Not used.				
36	Malleable-iron threaded pipe unions ASME B16.39	X	X		
37	Not used.				

A - Cold Water Aboveground
B - Hot Water 180 degrees F Maximum Aboveground
C - Compressed Air Lubricated
D - Cold Water Service Belowground
Indicated types are minimum wall thicknesses.
** - Type L - Hard
*** - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors
**** - In or under slab floors only brazed joints

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

-- End of Section Table of Contents --

SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 350	(1986) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
ARI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AIR DIFFUSION COUNCIL (ADC)

ADC 1062:GRD	(1984) Test Codes for Grilles, Registers and Diffusers

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210	(1985) Laboratory Methods of Testing Fans for Rating
AMCA 300	(1996) Reverberant Room Method for Sound Testing of Fans

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

AFBMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 181	(2000) Carbon Steel Forgings for General-Purpose Piping
ASTM A 193	(2000) Alloy-Steel and Stainless Steel

	Bolting Materials for High-Temperature Service
ASTM A 234	(2000) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 525	(1993) General Requirement for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A 733	(1999) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM D 520	(2000) Zinc Dust Pigment
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM E 437	(1992; R 1997) Industrial Wire Cloth and Screens (Square Opening Series)

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1998) Power Piping
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Steel

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA HVAC Duct Const Stds	(1995; Addenda Nov 1997) HVAC Duct Construction Standards - Metal and Flexible
SMACNA Install Fire Damp HVAC	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA Leakage Test Mnl	(1985) HVAC Air Duct Leakage Test Manual

UNDERWRITERS LABORATORIES (UL)

UL 214	(1997) Tests for Flame-Propagation of Fabrics and Films
UL 555	(1999) Fire Dampers
UL Bld Mat Dir	(1999) Building Materials Directory

1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be

submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G
Installation; G

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-03 Product Data

Components and Equipment; G

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

a. Ductwork Components

b. Air Systems Equipment

c. Electric Unit Heaters

Test Procedures

Proposed test procedures for ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

Welding Procedures

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

System Diagrams; G

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

Similar Services

Statement demonstrating successful completion of similar

services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

Welded Joints

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

Testing, Adjusting and Balancing

Proposed test schedules for ductwork leak test, and performance tests, at least 2 weeks prior to the start of related testing.

Field Training

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-06 Test Reports

Performance Tests

Test reports for the ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

SD-07 Certificates

Bolts

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, and the number of each type of bolt to be furnished.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer

regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

2.5 PIPING COMPONENTS

2.5.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Schedule 40, Grade A or B, Type E or S.

2.5.2 Joints and Fittings For Steel Pipe

Joints shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 1 inch and smaller shall be threaded; piping larger than 1 inch and smaller than 3 inches shall be either threaded, grooved, or welded; and piping 3 inches and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting according to MSS SP-25.

2.5.2.1 Welded Joints and Fittings

Welded fittings shall conform to ASTM A 234, and shall be identified with the appropriate grade and marking symbol. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11.

2.5.2.2 Flanged Joints and Fittings

Flanges shall conform to ASTM A 181 and ASME B16.5, Class 150. Gaskets shall be nonasbestos compressed material according to ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193.

2.5.2.3 Threaded Joints and Fittings

Threads shall conform to ASME B1.20.1. Unions shall conform to ASME B16.39, Class 150. Nipples shall conform to ASTM A 733. Malleable iron fittings shall conform to ASME B16.3, type as required to match piping.

2.5.3 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.6 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 10 hp or less. Adjustable frequency drives shall be used for larger motors.

2.7 CONTROLS

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

2.8 DUCTWORK COMPONENTS

2.8.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 1/2, 1, and 2 inch w.g. ductwork shall meet the requirements of Seal Class C. Class 3 through 10 inch shall meet the requirements of Seal Class A. Sealants shall have maximum 25 flame spread rating and 50

smoke developed rating (dry state). Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

2.8.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

2.8.1.2 General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

2.8.2 Ductwork Accessories

2.8.2.1 Duct Access Doors

Access doors shall be provided in ductwork and plenums where indicated, fire dampers, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds. Doors shall be minimum 15 x 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 x 24 inches or larger shall be provided with fasteners operable from both sides.

2.8.2.2 Fire Dampers

Fire dampers shall be 1-1/2 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specific application, and shall be installed according to their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Fire dampers shall be curtain type with damper

blades in the air stream. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall. Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.8.2.3 Splitters and Manual Balancing Dampers

Splitters and manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Splitters shall be operated by quadrant operators or 3/16 inch rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 8 inches. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 12 inches. Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

2.8.2.4 Air Deflectors and Branch Connections

Air deflectors shall be provided at duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections may be used in lieu of deflectors or extractors for branch connections. All air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be provided with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid and adjustable blade and lock. Adjustment shall be easily made from the face of the outlet or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein. Fixed air deflectors, also called turning vanes, shall be provided in 90 degree elbows.

2.8.3 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.8.3.1 Duct Sleeves

Duct sleeves shall be provided for round ducts 15 inches in diameter or less passing through floors, walls, or roof, and installed during construction of the floor, wall, or roof. Round ducts larger than 15 inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared

openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for insulated ducts.

2.8.3.2 Framed Prepared Openings

Openings shall have 1 inch clearance between the duct and the opening or 1 inch clearance between the insulation and the opening for insulated ducts.

2.8.3.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round ducts larger than 15 inches and square, and rectangular ducts shall be fabricated from 18 gaugegalvanized steel. Collars shall be installed with fasteners on maximum 6 inch centers, except that not less than 4 fasteners shall be used.

2.8.4 Registers and Grilles

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ADC 1062:GRD. Inlets and outlets shall be sound rated and certified according to ADC 1062:GRD. Sound power level shall be as indicated. Registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all registers. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen according to NFPA 90A.

Units shall be four-way directional-control type, except that exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

2.8.5 Louvers

Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

2.8.6 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, Type I, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire. Frames shall be removable type, or stainless steel or extruded aluminum.

2.9 AIR SYSTEMS EQUIPMENT

2.9.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 150 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.9.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed and be single-width single-inlet for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. Fan blades may be forward curved, backward-inclined or airfoil design. Fan wheel diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have dripproof enclosures. Motor starters shall be as indicated in Division 16.

2.9.1.2 Centrifugal Type Power Roof Ventilators

Fans shall be V-belt driven with backward inclined, non-overloading wheel. Motor compartment housing shall be hinged or removable and weatherproof, constructed of heavy gauge aluminum. Fans shall be provided with birdscreen, disconnect switch, and gravity dampers. Motors enclosure shall be dripproof type. Lubricated bearings shall be provided.

2.10 TERMINAL UNITS

2.10.1 Electric Unit Heaters

Units shall include an enclosure, metal casing with oven baked polyester paint finish, resistance heating coil assembly, fan assembly, motor, and controls. Sound power level data or values for these units shall be obtained according to test procedures based on ARI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles, when handling standard flow for which the unit air capacity is rated. Each unit shall be secured to the building structure. Capacity of the unit shall be as indicated. Unit shall be of draw-thru horizontal discharge type with automatic controls arranged to properly heat the room. All units shall have single supply circuit with fuses as required by NEC for element and motor protection. Automatic controls shall be provided as specified in paragraph: CONTROLS. Sequence of control shall be any one of the standard ANSI cycles specified in paragraph: CONTROLS. Units shall be furnished with wall mounting hardware and common remote room thermostat(1 thermostat to control 2 units).

2.10.1.1 Enclosures

Enclosures shall be fabricated of not lighter than 16 gauge galvanized steel, reinforced and braced, or all welded framework with panels to provide equivalent strength. The exposed side shall be high density, erosion-proof material suitable for use in air streams with velocities up to 4,500 fpm. Front panel shall be designed for easy removal by one person. Discharge grilles shall have adjustable vanes and shall properly distribute air throughout the space. Plastic discharge or return grilles are not acceptable. Removable panels or access doors shall be provided for service and control compartments. Fan switch shall be key operated or accessible through a locked access panel. Gaskets shall be provided at the back and bottom of the unit for effective air seal, as required.

2.10.1.2 Electric Resistance Heating Elements

Electric resistance heating elements shall be of the sheathed, finned, tubular type, or of the open resistance type designed for direct exposure to the air stream. Heating element electrical characteristics shall be as indicated. Where fan motor or control voltage is lower than required for the electric resistance heating element, a fused factory mounted and wired transformer shall be provided. Provide reset thermal cutouts to protect from over-temperature.

2.10.1.3 Fans

Fans shall be of the galvanized steel or aluminum, multiblade, centrifugal type, dynamically and statically balanced. Fan housings shall be provided with resilient mounted, self-aligning permanently lubricated ball bearings, sleeve bearings, or combination ball and sleeve bearings, capable of not less than 2000 hours of operation on one oiling. Fans shall be

direct-connected. Fans shall have a thermal delay switch for energy savings.

2.10.1.4 Motors

Motors shall be of the permanent split-capacitor type with built-in thermal overload protection and automatic reset. Motor shall be isolated from the casing and shall be suitable for operation on electric service available.

2.11 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123or ASTM A 525 shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatized and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 1/8 inch. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

3.1.1 Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall be not less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inch or less in diameter, and with flanges for pipe 3 inches and larger. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. All piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete

floor slabs shall be welded.

3.1.1.1 Joints

a. Threaded Joints: Threaded joints shall be made with tapered threads and made tight with a stiff mixture of graphite and oil or polytetrafluoroethylene tape or equivalent thread joint compound or material, applied to the male threads only.

c. Welded Joints: Welding shall be according to qualified procedures using qualified welders and welding operators. Procedures and welders shall be qualified according to ASME BPV IX. Welding procedures qualified by others and welders and welding operators qualified by another operator may be permitted by ASME B31.1. All welds shall be permanently identified by imprinting the welder's or welding operator's assigned symbol adjacent to the weld. Welded joints shall be fusion welded unless otherwise required. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. Electrodes shall be stored and dried according to AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.1.2 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.1.2 Supports

3.1.2.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.2.2 Seismic Requirements (Pipe Supports and Structural Bracing)

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section.

3.1.2.3 Pipe Hangers, Inserts and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Types 5, 12, and 26 shall not be used.

b. Inserts: Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

c. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.

h. Horizontal Pipe Supports: Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

i. Vertical Pipe Supports: Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

j. Pipe Guides: Type 35 guides using steel reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

k. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger with medium 60 degrees F or greater, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

l. High Temperature Guides with Cradles: Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.1.3 Equipment and Installation

Frames and supports shall be provided for fans and other similar items

requiring supports. Electrical unit heaters shall be wall mounted as indicated. The method of anchoring and fastening shall be as detailed. Floor-mounted equipment, unless otherwise indicated, shall be set on not less than 4 inch concrete pads or curbs doweled in place. The concrete foundation shall be of a mass not less than three times the weight of the components to be supported. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03305 CONCRETE.

3.1.4 Access Panels

Access panels shall be provided for concealed controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced.

3.1.5 Flexible Connectors

Flexible connectors shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.1.6 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed for fire rated penetrations. For non-fire rated penetrations, the space shall be packed with a sealant.

3.1.7 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

3.1.8 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

3.1.9 Power Roof Ventilator Mounting

Foamed 1/2 inch thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange.

3.1.10 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior

to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2 FIELD PAINTING AND COLOR CODE MARKING

Finish painting of items only primed at the factory, surfaces not specifically noted otherwise, and color code marking for piping shall be as specified in Section 09900 PAINTING, GENERAL.

3.3 PIPING HYDROSTATIC TEST

After cleaning, water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Leaks shall be repaired and piping retested until test is successful. No loss of pressure will be allowed. Leaks shall be repaired by re-welding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before covering or concealing.

3.4 DUCTWORK LEAK TEST

Ductwork leak test shall be performed for the entire air distribution and exhaust system, including fans. Test procedure, apparatus, and report shall conform to SMACNA Leakage Test Mnl. Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior.

3.5 CLEANING AND ADJUSTING

Inside of ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.6 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.7 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than 2 days

for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the ambient temperature in a shaded and weather protected area.

3.8 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 40 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15950

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS

-- End of Section Table of Contents --

SECTION 15950

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G

Drawings on A1 34 by 22 inch sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and device identifiers shown. Each control-system element on a drawing shall have a unique identifier as shown. All HVAC control system drawings shall be delivered together as a complete submittal. Drawings shall be submitted for each HVAC system.

a. HVAC control system drawings shall include the following:

Sheet One: Drawing index, HVAC control system legend.

Sheet Two: Valve schedule, damper schedule.

Sheet Three: Compressed air station schematic.

Sheet Four: HVAC control system schematic and equipment schedule.

Sheet Five: HVAC control system sequence of operation and ladder diagram.

Sheet Six: HVAC control panel arrangement, control panel cross-section, and control panel inner door layout.

Sheet Seven: HVAC control panel back-panel layout.

Sheet Eight: Control loop wiring diagrams.

Sheet Nine: Motor starter and relay wiring diagram.

Note: Repeat sheets four through nine for each AHU system.

b. An HVAC control system drawing index showing the name and number of the building, military site, State or other similar designation, and Country. The drawing index shall list all HVAC control system drawings, including the drawing number, sheet number, drawing title, and computer filename when used.

c. An HVAC control system legend showing generic symbols and the name of devices shown on the HVAC control system drawings.

d. A valve schedule showing each valve's unique identifier, size, flow coefficient (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure data, dimensions, and access and clearance requirements data.

e. A damper schedule showing each damper and actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive positioner ranges, locations of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The damper schedule shall include the maximum leakage rate at the operating static-pressure differential. The damper schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance requirements.

f. A compressed-air station schematic diagram showing all equipment, including: compressor with motor horsepower and voltage; starter; isolators; manual bypasses; tubing sizes; drain piping and drain traps; reducing valves; dryer; and data on manufacturer's names and model numbers, mounting, access, and clearance requirements. Air compressor and air dryer data shall include calculations of the air consumption of current-to-pneumatic transducers and any other control system devices to be connected to the compressed air station, and the compressed air supply dewpoint temperature at 20 psig.

g. An HVAC control system equipment schedule showing the control loop, device unique identifier, device function, setpoint, input range, and additional important parameters (i.e. output range).

h. An HVAC control system sequence of operation.

i. An HVAC control system ladder diagram showing all relays, contacts, pilot lights, switches, fuses and starters connected to

the control system.

j. HVAC control panel arrangement drawings showing both side and front views of the panel. The drawing shall show panel and mounting dimensions.

k. HVAC control panel cross-section drawings showing mounting rails and standoffs for devices.

l. HVAC control panel inner door layout drawings showing both front and rear views of the inner door. The drawings shall show device locations, labels, nameplate legends, and fabrication details.

m. HVAC control panel back-panel layout drawings showing device locations, labels, nameplate legends, terminal block layout, fabrication details, and enclosure operating temperature-rise calculations.

n. HVAC control system wiring diagrams showing functional wiring diagrams of the interconnection of conductors and cables to HVAC control panel terminal blocks and to the identified terminals of devices, starters and package equipment. The wiring diagrams shall show all necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for HVAC control systems and for packaged-equipment control systems shall be identified back to the panel-board circuit breaker number, HVAC system control panel, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

SD-03 Product Data

HVAC Control System; G
Service Organizations; G

Six copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name, address, technical point of contact and telephone number, and contractual point of contact and telephone number.

Equipment Compliance Booklet; G

An HVAC control system equipment compliance booklet (ECB) in indexed booklet form with numbered tabs separating the information on each device. It shall consist of, but not be limited to, data sheets and catalog cuts which document compliance of all devices and components with the specifications. The ECB shall be indexed in alphabetical order by the unique identifiers. Devices and components which do not have unique identifiers shall follow the devices and components with unique identifiers and shall be indexed in alphabetical order according to their functional name. The ECB shall include a bill of materials for each HVAC control system. The bill of materials shall function as the table of contents for the ECB and shall include the device's unique

identifier, device function, manufacturer, model/part/catalog number used for ordering, and tab number where the device information is located in the ECB.

Commissioning Procedures

a. Six copies of the HVAC control system commissioning procedures, in indexed booklet form, 60 days prior to the scheduled start of commissioning. Commissioning procedures shall be provided for each HVAC control system, and for each type of terminal-unit control system. The commissioning procedures shall reflect the format and language of this specification, and refer to devices by their unique identifiers as shown. The commissioning procedures shall be specific for each HVAC system, and shall give detailed step-by-step procedures for commissioning of the system.

b. Commissioning procedures documenting detailed, product-specific set-up procedures, configuration procedures, adjustment procedures, and calibration procedures for each device. Where the detailed product-specific commissioning procedures are included in manufacturer supplied manuals, reference may be made in the HVAC control system commissioning procedures to the manuals.

c. Commissioning procedures documenting controller configuration checksheets for each controller listing all configuration parameters, dip switch and jumper settings, and initial recommended P, I and D values. The configuration parameters shall be listed in the order in which they appear during the configuration process. Each configuration parameter shall be noted as being: set per specs with no field adjustment required, set per specs but field adjustable, or not applicable.

d. Commissioning procedures showing a time clock configuration checksheet listing all parameters, and switch settings. The parameters shall be listed in the order which they appear during the setup process.

e. An HVAC control system commissioning procedures equipment list that lists the equipment to be used to accomplish commissioning. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Performance Verification Test Procedures

Six copies of the HVAC control system performance verification test procedures, in indexed booklet form, 60 days before the Contractor's scheduled test dates. The performance verification test procedures shall refer to the devices by their unique identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation. An HVAC control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Training Course Requirements

Six copies of HVAC control system training course material 30 days prior to the scheduled start of the training course. The training course material shall include the operation manual, maintenance and repair manual, and paper copies of overheads used in the course. An HVAC control system training course, in outline form, with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least 60 days prior to the start of the training.

SD-06 Test Reports

Commissioning Report

Six copies of the HVAC control system commissioning report, in indexed booklet form, within 30 days after completion of the system commissioning. The commissioning report shall include data collected during the HVAC control system commissioning and shall follow the format of the commissioning procedures. The commissioning report shall include all controller and time clock checksheets with final values listed for all parameters, setpoints, P, I, D setting constants, calibration data for all devices, and results of adjustments.

Performance Verification Test

Six copies of the HVAC control system performance verification test report, in indexed booklet form, within 30 days after completion of the test. The HVAC control system performance verification test report shall include data collected during the HVAC control system performance verification test. The original copies of data gathered during the performance verification test shall be turned over to the Government after Government approval of the test results.

SD-10 Operation and Maintenance Data

Operation Manual
Maintenance and Repair Manual

Six copies of the HVAC control system operation manual for each HVAC control system 30 days before the date scheduled for the training course.

1.3 GENERAL REQUIREMENTS

1.3.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.3.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange

such work accordingly, and shall furnish all work necessary to meet such conditions.

1.4 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

1.5 OPERATION MANUAL

An HVAC control system operation manual for each HVAC control system, in indexed booklet form, shall be provided. The operation manual shall include the HVAC control system sequence of operation, and procedures for the HVAC system start-up, operation and shut-down. The operation manual shall include as-built HVAC control system detail drawings. The operation manual shall include the as-built controller configuration checksheets, the as-built time clock configuration checksheet, the HVAC control system front panel description, the procedures for changing HVAC system controller setpoints, the procedures for gaining manual control of processes, the time clock manufacturer's manual control of processes, the time clock manufacturer's operation manual, and the controller manufacturer's operation manual.

a. The HVAC control system front panel description shall explain the meaning and use of the lights, switches, gauges, and controller displays located in the front panel. Each light, switch, gauge, and display described shall be numbered and referenced to a drawing of the front panel.

b. The procedures for changing HVAC system controller setpoints shall describe the step-by-step procedures required to change: the process variable setpoints of controllers, the alarm setpoints of controllers, the controller bias settings, and controller setpoint reset schedules.

c. The procedures for gaining manual control of processes shall describe step-by-step procedures required to gain manual control of devices and manually adjust their positions.

1.6 MAINTENANCE AND REPAIR MANUAL

An HVAC control system maintenance and repair manual for each HVAC control system, in indexed booklet form in hardback binders, shall be provided. The maintenance and repair manual shall include the routine maintenance checklist, a recommended repair methods list, a list of recommended maintenance and repair tools, the qualified service organization list, the as-built commissioning procedures and report, the as-built performance verification test procedures and report, and the as-built equipment data booklet (EDB).

a. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all devices listed in the equipment compliance booklet (ECB), the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or

reference.

b. The recommended repair methods list shall be arranged in a columnar format and shall list all devices in the equipment compliance booklet (ECB) and state the guidance on recommended repair methods, either field repair, factory repair, or whole-item replacement.

c. The as-built equipment data booklet (EDB) shall include the equipment compliance booklet (ECB) and all manufacturer supplied user manuals and information.

d. If the operation manual and the maintenance and repair manual are provided in a common volume, they shall be clearly differentiated and separately indexed.

PART 2 PRODUCTS

2.1 MATERIAL AND EQUIPMENT

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty period.

2.2 GENERAL EQUIPMENT REQUIREMENTS

2.2.1 Electrical and Electronic Devices

All electrical and electronic devices shall have a NEMA Type 1 enclosure in accordance with NEMA 250 unless otherwise shown.

2.2.2 Ambient Temperature Limits

All instruments shall operate within limit ratings of 35 to 130 degrees F and 10 percent to 95 percent relative humidity, noncondensing. All devices installed outdoors shall operate within limit ratings of minus 35 to plus 150 degrees F.

2.2.3 Nameplates, Lens Caps, and Tag Nameplates

Nameplates, lens caps, and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire.

2.3 MATERIALS

2.3.1 Wiring

2.3.1.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

2.3.1.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 300-volt service.

2.3.1.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 600-volt service.

2.3.1.4 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single or multiple-twisted, minimum 2 inch lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.4 THERMOSTATS

Thermostat ranges shall be selected so that the setpoint is adjustable between plus or minus 10 degrees F of the setpoint shown. Thermostats shall be electric or low-voltage electronic. Mount thermostats 5 feet above finish floor.

2.4.1 In-line Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Thermostats shall be enclosed with separate locking covers (guards). Thermostats shall have manual "OFF/AUTO" switches as required by the application.

2.4.2 Heating Thermostat

Heating thermostat shall be a 2-step controller provided with fixed heat anticipation and "AUTO-OFF" switch. Thermostats shall be provided with external temperature setting devices with a factory set maximum of 68 degrees F. Heating thermostats shall have an adjustable range of at least 13 degrees F below 68 degrees F. Thermostat shall be furnished with electric unit heaters for field wiring.

2.5 CONTROL DEVICES AND ACCESSORIES

Except where otherwise specified, control device and accessory input impedance shall not exceed 250 ohms.

2.5.1 Relays

Relays shall be 2-pole, double-throw (2PDT) with a 10-ampere resistive rating at 120 Vac, and shall have an enclosed 120-Vac coil with 8 pin blade connectors, and a matching rail-mounted socket. Power consumption shall not be greater than 3 watts.

2.6 PILOT LIGHTS AND MANUAL SWITCHES

Pilot lights and switches shall be rectangular devices arranged in a horizontal matrix as shown. Momentary switches shall be non-illuminated. Interlocking switches shall have separately illuminated sections. Device illumination shall be by light-emitting diode or neon lamp.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION CRITERIA

The HVAC control system shall be completely installed and ready for operation, as specified and shown. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. The HVAC control system installation shall provide clearance for control system maintenance. The control system installation shall not interfere with the clearance requirements for mechanical installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.1 Device Mounting Criteria

Devices mounted on building surfaces shall be installed in accordance with manufacturer's recommendations and as shown.

3.1.2 Wiring Criteria

Wiring including low-voltage wiring, shall be installed in metallic raceways. Wiring shall be installed without splices between control devices and HVAC control panels. Instrumentation grounding shall be installed as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Cables and conductors shall be tagged at both ends, with the identifier shown on the shop drawings, in accordance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Other electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown.

3.1.2.1 Power-Line Surge Protection

All equipment connected to ac circuits shall be protected from powerline surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

3.1.2.2 Surge Protection for Transmitter and Control Wiring

All HVAC system control panel equipment shall be protected against surges induced on control and transmitter wiring. The equipment protection shall be tested in the normal mode and in the common mode, using the following two waveforms:

a. A 10-microsecond by 1000-microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8-microsecond by 20-microsecond waveform with a peak voltage of 1000 volts and a peak current of 1000 amperes.

3.1.2.3 Controller Output Loop Impedance Limitation

Controller output loops shall be constructed so that total circuit impedance connected to the analog output of a single-loop controller shall not exceed 600 ohms.

3.2 CONTROL SYSTEM INSTALLATION

3.2.1 Room-Instrument Mounting

Room instruments shall be mounted so that their sensing elements are 5 feet above the finished floor unless otherwise shown. Temperature setpoint device shall be recess mounted.

3.3 CONTROL SEQUENCES OF OPERATION

3.3.1 System Requirements

These requirements shall apply to all HVAC systems unless modified herein. The sequences describe the actions of the control system for one direction of change in the HVAC process analog variable. The reverse sequence shall occur when the direction of change is reversed.

3.3.1.1 HVAC System Supply and Exhaust Fans

a. Supply Fan SF-1 shall be started/stopped by electrical interlock with gate's motors and manual wall mounted switch located in Control Room. All SF-1 related wiring, including interlock wiring, relays, and switches shall be provided by Division 16000.

b. Exhaust Fans EF-1 and EF-2 shall be controlled by corresponding in-line cooling only thermostats (furnished and installed by Division 15000, wired by Division 16000).

c. Exhaust Fan EF-3 shall be started/stopped by electrical interlock with toilet room light switch.

3.3.2 Electric Unit-Heaters

A wall-mounted thermostat with an "AUTO-OFF" switch located as shown, shall cycle the units to maintain its setpoint as shown when the switch is in the "AUTO" position. When the switch is in the "OFF" position, the units shall be stopped.

3.4 COMMISSIONING PROCEDURES

3.4.1 General Procedures

3.4.1.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, tune the controllers, and make any necessary control-system corrections to ensure that the systems function as described in paragraph: CONTROL SEQUENCES OF OPERATION. The Contractor shall permanently record, on system equipment schedule, the final setting of controller setpoint, manual reset setting, maximum and

minimum controller output, and settings, in units and terminology specific to the controller.

3.4.1.2 Item Check

An item-by-item check of the sequence of operation requirement shall be performed using Steps 1 through 3 in the specified control system commissioning procedures. Steps 1 and 2 shall be performed with the HVAC system shutdown; Step 3 shall be performed after the HVAC systems have been started. Signals used to change the mode of operation shall originate from the actual HVAC control device intended for the purpose, such as the thermostats and switches. With each operational-mode change signal, pilot lights and HVAC-panel output-relay contacts shall be observed to ensure that they function.

3.4.1.3 Weather-Dependent Test Procedures

Weather-dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the Contractor shall verify the actual results in the appropriate season.

3.4.1.4 Configuration

The Contractor shall configure each controller for its specified service.

3.4.1.5 Two-Point Accuracy Check

A two-point accuracy check of the calibration of each HVAC-control-system sensing element and transmitter shall be performed by comparing the HVAC-control-panel readout to the actual value of the variable measured at the sensing element and transmitter. Digital indicating test instruments shall be used, such as digital thermometers. The test instruments shall be at least twice as accurate as the specified sensing element-to-controller readout accuracy. The calibration of the test instruments shall be traceable to NIST standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-controller readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

3.4.1.6 Controller-Tuning Procedure

The Contractor shall perform a controller-tuning procedure, which shall consist of setting the initial controller setpoints, and logging the settings. Tuning shall be self-tuning operation by the controller.

3.4.2 Electric Unit Heaters EUH-1, EUH-2 and Exhaust Fans EF-1, EF-2

The "OFF/AUTO" switch shall be placed in the "OFF" position. Each space-thermostat temperature setting shall be turned up so that it makes contact to turn on the unit-heater fans and exhaust fans. The fans shall not start. The "OFF/AUTO" switch shall be placed in the "AUTO" position. The fans shall start. Each space-thermostat temperature setting shall be turned down, and the fans shall stop. The thermostats shall be set at their temperature setpoints shown. The results of testing of one of each type of unit shall be logged.

3.4.3 Heating and Ventilating

Steps for installation are as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. The system shall be checked to see that power is available for the HVAC equipment.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for space temperature shall be checked.

c. Step 3 - Control-System Commissioning:

(1) The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check for sensing element-to-controller readout shall be performed. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the controller-tuning procedure shall be performed. The temperature setpoint device shall be set to the space temperature setpoint as shown.

(2) With the HVAC system running, temperature controller (thermostat) input signal shall be simulated, at the device. It shall be verified that the controlled equipment turns on and off as required. The thermostats shall be set at the setpoint as shown.

(3) With the HVAC system running, a gate's motor trip input signals shall be simulated at each motor, and verification of control-device actions and interlock functions as described in the Sequence of Operation shall be made including simulation of the SF-1 start/stop switch and toilet room light switch. Simulation shall be performed without false-alarming any Life Safety systems.

3.5 BALANCING, COMMISSIONING, AND TESTING

3.5.1 Coordination with HVAC System Balancing

Commissioning of the control system, except for tuning of controllers, may be performed prior to or simultaneous with HVAC system balancing. The Contractor shall tune the HVAC control system after all air-system balancing has been completed, minimum damper positions set and a report has been issued.

3.5.2 Control System Calibration, Adjustments, and Commissioning

Control system commissioning shall be performed for each HVAC system, using test plans and procedures previously approved by the Government. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform commissioning and testing of the HVAC control system. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Mechanical control devices shall be adjusted to operate as specified. Written notification of any planned commissioning

or testing of the HVAC Control systems shall be given to the Government at least 14 calendar days in advance.

3.5.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the commissioning report and completion of balancing.

3.5.4 Posted Instructions

Instructions on 8-1/2-by-11-inch sheets and half-size plastic laminated drawings for each system, showing the final installed conditions, shall be placed at the government approved locations. The posted instructions shall include the control sequence, control schematic, ladder diagram, wiring diagram, commissioning procedures, controller configuration check sheet with final configuration record, preventive maintenance instructions and single-loop controller operators manual.

3.6 TRAINING

3.6.1 Training-Course Requirements

A training course shall be conducted for operating staff members designated by the Contracting Officer. The training period, for a total of 32 hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site. The Contractor shall be responsible for furnishing all audiovisual equipment and all other training materials and supplies. A training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. Contractor shall submit an outline for the course, with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the start of the training.

3.6.2 Training-Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the operating and maintenance instructions, the layout of one of each type of unitary equipment and the locations of each, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control-system performance by which to measure operation and maintenance effectiveness.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15990

TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS

-- End of Section Table of Contents --

SECTION 15990

TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S1.4	(1983; S1.4A) Sound Level Meters
ANSI S1.11	(1986) Octave-Band and Fractional-Octave-Band Analog and Digital Filters

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 111	(1988) Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(1989) National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB-01	(1991) Procedural Standards for Testing-Adjusting-Balancing of Environmental Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-07	(1993) HVAC Systems - Testing, Adjusting and Balancing

1.2 GENERAL REQUIREMENTS

The Contractor shall select AABC MN-1, NEBB-01, SMACNA-07 or ASHRAE 111 as the standard for providing testing, adjusting and balancing of air systems. The selected standard shall be used throughout the project. Testing,

adjusting, and balancing shall be accomplished by a firm certified for testing and balancing by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Prior to testing, adjusting, and balancing, the Contractor shall verify that the systems have been installed and are operating as specified. Approved detail drawings and all other data required for each system and/or component to be tested shall be made available at the jobsite during the entire testing, adjusting and balancing effort. The Contractor shall verify that all balancing devices are properly installed to permit testing, adjusting and balancing and that all duct leakage tests have been completed prior to testing, adjusting and balancing. The Contracting Officer shall be notified in writing of all equipment, components, or balancing devices, that are damaged, incorrectly installed, or missing, as well as any design deficiencies that will prevent proper testing, adjusting, and balancing. Testing, adjusting, and balancing shall not commence until approved by the Contracting Officer. Instrumentation accuracy shall be in accordance with the standard selected in this paragraph. Sound level measuring equipment shall be rated in accordance with ANSI S1.4 and ANSI S1.11.

1.3 INSTRUMENT ACCURACY REQUIREMENTS

All instrumentation shall be checked for accuracy before beginning testing, adjusting and balancing procedures. Instrument accuracy shall be in accordance with the standard selected in paragraph: GENERAL REQUIREMENTS. Checks may be carried out against similar equipment maintained specifically for checking purposes or by the manufacturer or a recognized testing facility. All instrumentation used for testing shall be calibrated within 6 months of use. Pitot tubes and U-tube manometers do not require checking. In no case shall the instrumentation accuracy be less than specified by the instrument manufacturer. Any instrument falling out of calibration during the process of balancing and testing shall be recalibrated or removed from the site and replaced by a properly calibrated instrument. No instruments shall be allowed to remain on-site that are not in calibration.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Testing and Balancing

Three copies of a preliminary report, 30 days before balancing commences. The report shall be organized by specific systems and shall clearly identify each item of equipment to be tested, adjusted, and balanced. The appropriate test procedures and measurements to be taken for each item of equipment shall be listed. Instrument calibration records shall be provided on forms shown in AABC MN-1 or SMACNA-07. Manufacturer's specified accuracy shall be shown. The report shall include floor plans showing all measurement locations and types of measurements to be made. All related data necessary for testing, balancing, and adjusting, including fan curves and pump curves, shall be included. A system readiness checklist, similar to that shown in

SMACNA-07, shall be included. The report shall contain a listing of the deficiencies of all systems to be tested, adjusted and balanced and the corrective action taken. The report shall contain a schedule for the testing and balancing. Six copies of the final report on forms shown in AABC MN-1 or SMACNA-07, 30 days after completion of the test and balance operation. Data shall be in a hard bound cover identifying the project name, location, date of submittal, name of Contractor, and a general title indicating the specific area and type of work, and shall be signed by a registered professional engineer, employed by the test and balance firm, who has a minimum of 2 years experience in testing, adjusting and balancing work. The final report shall include a summary describing test methods, test results, and major corrective actions taken. The report shall include as-tested floor plans showing all measurement locations and types of measurements made. Air distribution data shall include coded drawings which show the exact location of each air outlet.

All instruments that are recalibrated and brought back onto the jobsite after being found to be out of calibration shall have recalibration records submitted on forms shown in AABC MN-1 or SMACNA-07.

SD-07 Certificates

Qualification

Qualification data, 90 days prior to testing and balancing operations. The test and balance firm shall be certified by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB). The lead balancing technician shall be qualified by AABC or NEBB and his qualification data shall include past experience on at least five similar projects.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 TESTING AND BALANCING

3.1.1 General

The facility shall be essentially complete with final walls, doors, and partitions in place. Doors surrounding each area to be balanced shall be closed during testing and balancing operations. Air systems shall be complete and operable with balancing dampers, ducting, outlets, inlets, and control components in place. Exhaust and supply fans shall be operational. All measurements and adjustments shall be made using procedures described in standard selected in paragraph: GENERAL REQUIREMENTS. Air motion and distribution from air terminals shall be as shown. Smoke tests may be used to demonstrate proper air distribution from air terminals. All data including deficiencies encountered and corrective action taken shall be recorded. If a system cannot be adjusted to meet the design requirements, the Contractor shall promptly notify the Contracting Officer in writing.

3.1.2 Air Systems

Each system shall be adjusted until all flow quantities are within plus ten

percent and minus zero percent. Dampers shall be checked for tight shutoff. Air leakage around dampers shall be verified. Fans shall be checked for correct direction of rotation and proper speed shall be verified. Fire dampers shall be tested at system design air flow to insure proper closure in accordance with NFPA 90A and manufacturer's instructions prior to building occupancy.

3.1.2.1 General Balancing Methods

In addition to the requirements for specific systems, flows in supply and exhaust air systems shall be balanced using the methods in standard selected in paragraph: GENERAL REQUIREMENTS. Throttling losses shall be limited. Air flow adjustments shall be made by first adjusting the fan speed to meet the design flow conditions. Fan speed adjustment may not be required for fan motors which are less than one horsepower, or if throttling results in no greater than an additional 1/3 horsepower draw above that required if the fan speed were adjusted. Flows and pressures shall be checked in all main risers and supply ducts at all supply and exhaust fan discharges. All flows shall be recorded before and after each adjustment.

3.1.2.2 Specific Systems

All special or additional procedures for testing and balancing shall be in accordance with the applicable requirements of the standard selected in paragraph: GENERAL REQUIREMENTS. If a system has diversity, only the required quantity of wide open terminals shall be used to meet the design air flow.

3.1.3 Marking of Setting

Following final acceptance of certified reports by the Contracting Officer, the setting of all HVAC adjustment devices including splitters and dampers shall be permanently marked by the testing and balancing engineer so that adjustment can be restored if disturbed at any time.

3.1.4 Marking of Test Ports

The testing and balancing engineer shall permanently and legibly mark and identify the location points of the duct test ports. All penetrations through ductwork shall be properly sealed to prevent air leakage or loss of vapor barrier.

3.1.5 Sound Level Testing

After the systems are properly tested, adjusted and balanced, sound levels shall be checked in accordance with the applicable provisions of AABC MN-1. Octave-band analysis and noise-criteria curve data shall be recorded on forms shown in AABC MN-1. All occupied areas shall be verified to be within the sound levels shown or as specified. Any areas not meeting the requirements of AABC MN-1 or the specifications or drawings shall be clearly indicated on the form and an explanation of all discrepancies shall be provided in test report.

3.2 CONTROL SYSTEMS

Testing, adjusting, and balancing of the systems shall be coordinated with the control system installation. All control components shall be verified to be properly installed and operating as specified before proceeding with

testing, adjusting, and balancing. Verification shall be in accordance with AABC MN-1.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15995

COMMISSIONING OF HVAC SYSTEMS

SECTION 15995

COMMISSIONING OF HVAC SYSTEMS

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Commissioning Team; G

List of team members who will represent the Contractor in the pre-commissioning checks and functional performance testing, at least 2 weeks prior to the start of pre-commissioning checks. Proposed revision to the list, prior to the start of the impacted work.

Pre-commissioning Checks; G
Functional Performance Tests; G

Detailed procedures for pre-commissioning checks and functional performance tests, at least 4 weeks prior to the start of pre-commissioning checks.

Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of pre-commissioning checks.

SD-06 Test Reports

Pre-commissioning Checklists; G
Functional Performance Tests Checklist; G

Completed pre-commissioning checklists and functional performance test checklists organized by system and by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

1.2 SEQUENCING AND SCHEDULING

The work described in this Section shall begin only after all work required in related Sections, including Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS and Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS, has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 COMMISSIONING TEAM AND CHECKLISTS

The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. In addition, the Government will be represented by a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency. The team members shall be as follows:

Designation	Function
Q	Contractor's Chief Quality Control Representative
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing Representative
C	Contractor's Controls Representative
D	Design Agent's Representative
O	Contracting Officer's Representative
U	Using Agency's Representative

Each checklist shown in appendices A and B shall be completed by the commissioning team. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

3.2 TESTS

The pre-commissioning checks and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. The Contractor shall provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. A pre-commissioning check or functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. The Contractor shall reimburse the Government for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable) for Government commissioning team members.

3.2.1 Pre-Commissioning Checks

Pre-commissioning checks shall be performed for the items indicated on the pre-commissioning checklists in Appendix A. Deficiencies discovered during

these checks shall be corrected and retested in accordance with the applicable contract requirements.

3.2.2 Functional Performance Tests

Functional performance tests shall be performed for the items indicated on the checklists in Appendix B. Functional performance tests shall begin only after all pre-commissioning checks have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

APPENDIX A

PRE-COMMISSIONING CHECKLISTS

Pre-commissioning checklist - Piping

For Piping System

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Piping complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	X	___	X	___	X	___	X	___
c. Piping flushed and cleaned.	X	___	X	___	X	___	X	___
d. Flexible connectors installed as specified	__	___	X	X	X	___	X	___
e. Verify that piping has been labeled.	___	___	X	___	X	___	X	___
Testing, Adjusting, and Balancing (TAB)								
a. Hydrostatic test complete.	___	___	X	___	X	___	X	___
b. TAB operation complete.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Ductwork

For Supply Fan SF-1 and Exhaust Fan EF-1

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Ductwork complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	X	___	X	___	X	___	___	X
c. Ductwork leak test complete.	___	___	X	___	X	___	___	___
d. Verify open/closed status of dampers.	X	___	X	___	X	X	___	X
e. Flexible connectors installed as specified	X	___	X	X	X	X	___	X
Testing, Adjusting, and Balancing (TAB)								
a. TAB operation complete.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Electric Unit Heater

For Unit Heater: EUH-1 and EUH-2

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Electric power properly connected.	___	___	X	___	___	___	___	___
b. Any damage to units has been repaired.	___	___	X	___	X	___	___	___
c. Manufacturer's required maintenance/ operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	X	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Exhaust Fan

For Fan: SF-1, EF-1, EF-2, and EF-3

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Fan belt adjusted.	___	___	X	___	X	___	___	___
Electrical								
a. Power available to fan disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Control interlocks properly installed.	___	___	___	X	___	___	___	___
b. Control interlocks operable.	___	___	___	X	___	___	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB results +10%/-0% to cfm shown on drawings	___	___	X	___	X	___	___	___
b. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - HVAC System Controls

For HVAC System: SF-1, EF-1, EF-2, and EF-3

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. As-built shop drawings submitted.	___	___	X	X	___	___	___	___
b. Framed instructions mounted in or near control panel.	___	___	X	X	___	___	___	___
c. Components properly labeled (on inside and outside of panel).	___	___	X	X	___	___	___	___
d. Control components wired to each labeled terminal strip.	___	___	X	X	___	___	___	___
e. Control wiring labeled at all terminations, splices, and junctions.	___	___	X	X	___	___	___	___
Testing, Commissioning, and Balancing								
a. Testing, Commissioning, and Balancing Report submitted.	___	___	X	___	___	___	___	___

APPENDIX B

FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

Functional Performance Test Checklist - Electric Unit Heaters

The Contracting Officer will select unit heaters to be spot-checked during the functional performance test. The number of terminals shall not exceed 10 percent.

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters as per specifications including the following:

a. Verify unit heater response to room temperature set point adjustment. Changes to be heating set point to heating set point minus 10 degrees and return to heating set point. _____

b. Check blower fan speed. _____rpm

c. Check heating mode inlet air temperature. _____ degrees F

d. Check heating mode outlet air temperature. _____ degrees F

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's Testing, Adjusting and Balancing Representative _____

Contractor's Controls Representative _____

Contracting Officer's Representative _____

Using Agency's Representative _____

Functional Performance Test Checklist - HVAC Controls

For HVAC System: SF-1, EF-1, EF-2, and EF-3

The Contracting Officer will select HVAC control systems to undergo functional performance testing. The number of systems shall not exceed 10 percent.

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify that controller is maintaining the set point by manually measuring the controlled variable with a thermometer

b. Verify system stability by changing the controller set point as follows:

(1) Air temperature - 10 degrees F

(2) Static pressure - 10 percent of set point

The control system shall be observed for 10 minutes after the change in set point. Instability or excessive hunting will be unacceptable.

c. Verify interlock with other controls.

d. Change controller set point 10 percent with EMCS and verify correct response.

2. Verify that operation of control system conforms to that specified in the sequence of operation.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's Testing, Adjusting and Balancing Representative _____

Contractor's Controls Representative _____

Contractor's Officer's Representative _____

Using Agency's Representative _____

-- End of Section --